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PALEONTOGRAPHICAL SOCIETY.

BRITISH  
FOSSIL ECHINODERMATA

FROM

THE OOLITIC FORMATIONS.

VOLUME SECOND.

PART FIRST.

ON THE ASTEROIDEA.

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SUPPLEMENTARY MONOGRAPH

ON THE

MOLLUSCA

FROM THE

STONESFIELD SLATE, GREAT OOLITE, FOREST MARBLE,  
AND CORNBRAsh.

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1863.

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A MONOGRAPH  
ON THE  
BRITISH FOSSIL  
ECHINODERMATA

FROM  
THE OOLITIC FORMATIONS.

BY  
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THE ASTEROIDEA.

THE true star-fishes forming the order ASTEROIDEA have in general a depressed stelliform body, which sometimes assumes a polygonal or pentagonal figure. From the central disc five or more hollow rays proceed, containing prolongations of the internal organs (Pl. I, fig. 1). The entire upper surface is covered with a coriaceous integument, in which a series of calcareous pieces, often supporting spines, tubercles, and pedicellariæ, are developed (fig. 2, *a*). In the centre of the under surface is the mouth-opening, from whence radiate to the extremities of the rays as many ambulacra as there are lobes; in these, the tubular retractile feet are arranged in two or four rows; and the margins of the rays in many genera are bordered by well-developed spinigerous plates. (Pl. I, fig. 2, *b*.)

The skeleton of the ASTEROIDEA is a very complicated framework. It is composed of a great number of little bones or ossicula, articulated together in such a manner as to combine strength with flexibility. The ossicles vary in form and number in different parts of the skeleton; they have a persistent arrangement in the various genera, so that the ossicula of a star-fish afford us good evidence of the rank of its owner among the radiata, as the bones of a reptile or a mammal do amongst the vertebrata. The comparative anatomy of the skeleton of the ASTEROIDEA has not yet been worked out in



many genera, but we recommend the study of Tiedemann,<sup>1</sup> Meckel,<sup>2</sup> Sharpey,<sup>3</sup> and Müller's<sup>4</sup> works on the anatomy of some common species, as examples of what may be achieved in other groups, if correct observation and like diligence be brought to the task.

As the skeleton of the ASTEROIDEA is that part of their bodies which is most frequently

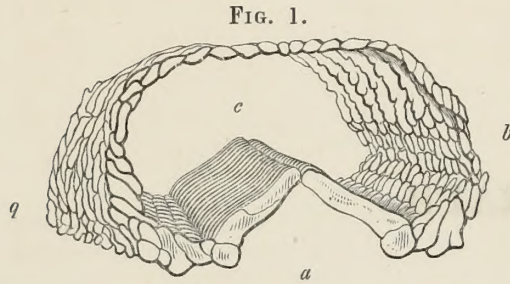


FIG. 1.  
Section of a ray of *Uraster rubens* showing the arrangement of the calcareous ossicula.

preserved in a fossil state, it is necessary that we should be well acquainted with the structure and relations of its different component parts. If, for example, we remove from the common star-fish, *Uraster rubens*, Lin., the integument and spines from the upper surface of the disc and rays, and afterwards the viscera enclosed therein, the structure of the ambulacral portion of the skeleton will be well exposed. It is seen to

consist of a central ring surrounding the mouth-opening, composed of ten larger and five smaller pieces firmly united together by ligaments; the ten larger pieces are disposed in pairs opposite the base of each ray, and the five smaller pieces occupy the interbrachial angles; the ten elements of the oral ring are perforated, for the passage of soft tubular organs.

Each ray is composed of a considerable number of small bones or ossicles, which form rings, as seen in fig. 1, representing the section of a ray of *Uraster rubens*, Lin. These bony circles succeed each other from the base to the apex, each segment being a repetition in form and position of all the others; the size of the rings, however, diminishing gradually from the base to the apex. The ossicles at the under part of the ray (*a*) are symmetrical, and articulated together in such a manner as to permit of considerable motion; their upper surface forms the floor of the cavity, in which prolongations of the digestive and other vital organs are contained (*c*); the under surface of the ossicles forms the ambulacral valley through which the tubular suckers pass. In fig. 1 *a* the two long femur-like bones at the bottom of the ring project obliquely upwards and inwards, and join each other in the median line; they are articulated at the base with other ossicula, which I shall presently describe. To the lateral parts of this central framework another series (*b b*) of larger ossicles are joined, which rise nearly parallel to each other like ribs encircling a thorax; they are connected by transverse osseous bars, and the whole is enveloped in the tegumentary membrane which encloses the upper portion of the rays. The ossicula are lined internally by a white, tough, fibrous membrane, which extends to the sides and floor of the ray, unites the ossicles together, and contributes to form

<sup>1</sup> Tiedemann, 'Anatomie der Röhrenholothurie des pomeranzenfarbigen Seesterns und Steinigels, Landshut, 1816, folio.

<sup>2</sup> Meckel, 'System der vergleichenden Anatomie,' Band ii, p. 19.

<sup>3</sup> 'Cyclopædia of Anatomy and Physiology,' Art. Echinodermata, from which figs. 1 and 2 are copied.

<sup>4</sup> Joh. Müller über den Bau der Echinodermen. 1854. 4to.



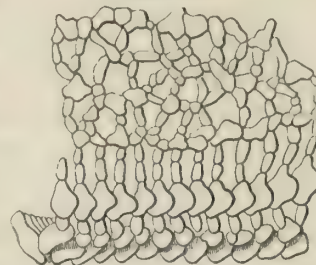
the compact, flexible mechanism so admirably exhibited in the arms of many species. Fig. 2 represents the lateral view of part of a ray of *Uraster rubens*, Lin., and exhibits the net-like arrangement of the ossicles on the sides and upper surface; this reticulate structure forms the inter-ambulacral portion of the skeleton.

The test of the ECHINOIDEA is formed of ambulacral and inter-ambulacral areas, and a similar arrangement of the ossicula may be observed in the skeleton of the ASTEROIDEA; the centrum of the disc or oral ring in the ASTERIIDÆ is the homologue of the centrum and auricular arches in the test of the ECHINIDÆ, to which the muscles of the jaws are attached; the centrum in both orders therefore forms the arch to which the ossicles of the rays in the star-fishes, and on which the plates in the sea-urchins, are supported.

The arches forming the central part of the base of the rays are the homologues of the ambulacral areas in the ECHINIDÆ; they are composed of two central, oblong principal pieces (fig. 1 a) united at the median line, and two smaller transverse pieces on which they rest, having two smaller inferior pieces external to the preceding; these six elements enter into the composition of a single segment of the ambulacral area. In a specimen of *Uraster rubens*, prepared as already described, for the purpose of displaying the skeleton, I have counted 140 ambulacral arches in each ray, which multiplied by 6 for the six elements in each arch,  $140 \times 6 = 840$  ossicles in one ray; this multiplied by 5 for the five rays,  $840 \times 5 = 4200$ , is the number of ossicles in the ambulacral portions of the skeleton of this specimen, exclusive of the elements of the centrum. The ossicles forming the lateral and upper portions of the ray are the homologues of the inter-ambulacral areas in the ECHINOIDEA (fig. 2). The number of separate pieces entering into the composition of this part of the skeleton is very great, arising from the smallness of the bones, and the diverse forms of their reticulate arrangement in the different genera, to form a structure at once resistant and flexible, and adapted to the habits of the organism (fig. 2); the inter-ambulacral areas of the ASTERIIDÆ are for this reason very unlike the homologous portion of the test in the ECHINIDÆ, where these areas consist of two columns of broad spinigerous plates, between which the narrow ambulacra are placed. In the ASTERIIDÆ, on the contrary, the ossicular elements of the inter-ambulacra, besides their locomotive functions, have assigned to them the formation of the sides and roof of the hollow cylindrical arms (fig. 1 c).

The structure of the rays varies so much in the different genera of this order, that any general description would necessitate the enumeration of so many exceptions to the common plan of organization, that I prefer pointing out the differences which several of the genera exhibit, rather than attempt to give a general outline of the entire group.

FIG. 2.



Reticulate arrangement of the ossicles on the sides and upper surface of a ray in *Uraster rubens*.

In the genus *Uraster* (Pl. I, fig. 2 *a, b*) the rays are long, and the ossicula on each side of the ambulacral valley support many rows of spines; the ossicles on the sides and upper surface of the ray form a hollow cavity for lodging the viscera (fig. 1 *c*); and the numerous small bones entering into this net-like structure support blunt or pointed spines (fig. 2 *a*), the integument between the osseous pieces is naked, and perforated by pores which communicate with the interior. Numerous pincers-like pedicellariæ, supported on soft stems, encircle the basis of the spines, or are distributed amongst them, whilst others are disposed at the angles of the rays. All the *Urasters* possess an excentral anal opening.

In Plate I, fig. 2 *a*, I have figured a portion of the upper surface of a ray of *Uraster tenuispinus*, M. and T., which shows the recurved spines raised upon the inter-ambulacral ossicles, and the naked integument between the spines perforated with respiratory pores. Pl. I, fig. 2 *b*, is the under surface of the same ray; four rows of tubular sucking-feet occupy the ambulacral valley, which is fringed with two rows of small spines arranged in an oblique comb-like order; external to these other rows of larger spines arm the lateral parts of the ray. Pl. I, fig. 3, represents a portion of the ambulacral skeleton, and shows the spaces for the passage of the tubular retractile feet.

The *Astropectens* have a stellate body, flattened on both sides, and furnished with two rows of tubular feet; in the ambulacral valleys, the rays are narrow and elongated, and their sides are bordered with two rows of large, regular, marginal plates (fig. 3). The ventral marginal plates carry long moveable spines, and the dorsal series in general are covered with granules more or less developed, which sometimes likewise carry spines. On the upper surface of the ray the inter-marginal space is thickly set with bunches of *paxillæ*, and the under surface is crowded with regular rows of short spines.

All these parts are well seen *in situ* in the section of a ray of the common Butthorn (*Astropecten aurantiacus*, Lin.) If the ray is laid open along the middle of the upper surface, and the dorsal integument and marginal plates are folded over into a horizontal position, the homology of the different parts of the ray, with the ambulacra and inter-ambulacra of the *Echinidæ* becomes evident.

The annexed figures of the upper and under surfaces of a ray of *Astropecten polyacanthus*, M. and T., shows the general structure of this part in the genus *Astropecten*. The ambulacral areas have two rows of tubular retractile feet; the valley is bounded by two rows of short,

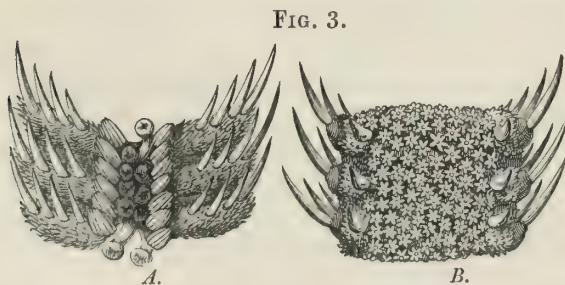


FIG. 3.  
Portion of a ray of *Astropecten polyacanthus*, M. and T. *A*, under surface; *B*, the upper surface of the ray.

stout spines, arranged in groups by the side of the suckers, each of the lower marginal plates is armed with four long, recurved, tooth-like spines (fig. 3 *A*), and other shorter spines cover the plates at their base; the upper marginal ossicles likewise support long, stout,



recurved spines, and the entire upper surface of the ray is crowded with stellate paxillæ, (fig. 3 *B*.)

In the *Solasters*, the disc is large; the rays, from twelve to fifteen in number, are short, about half the length of the diameter of the body. In the common Sun-star, *Solaster papposa*, Linn., one of the most common and handsome of British star-fishes, the structure is well exposed; fig. 4 *B* exhibits the upper surface, and fig. 4 *A* the under surface of this species: The disc is large and flat, one half the diameter of the body; the rays, in general twelve in number, are round and short, their length being about one half the diameter of the disc.

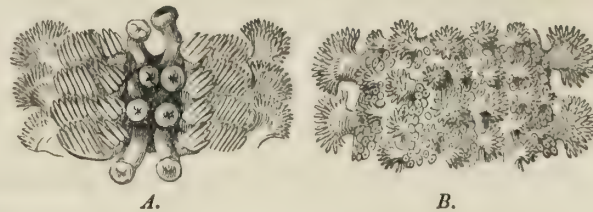


FIG. 4.  
Portion of a ray of *Solaster papposa*, Linn. *A*, the under;  
*B*, the upper surface.

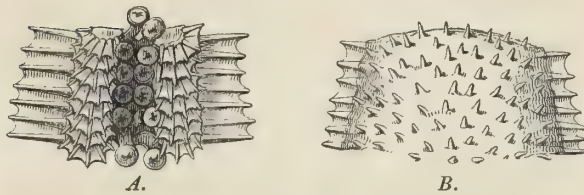
The entire upper surface is covered with tubercles, those on the disc are scattered over its surface, whilst they are arranged in regular rows on the rays. Each of these tubercles bears a bundle of long, spiculi-form, striated spines, fig. 4 *B* having from eighteen to twenty grouped in each fasciculus. In the rays there are in general five or six rows of spiniferous tubercles, those on the borders being the largest. The integument between the tubercles is naked, and perforated with many tentacule-pores (fig. 4 *B*); there are no pedicellariæ, and the vent is central; the madreporiform plate is excentral, and its surface is covered with fine radiating lamellæ. The under surface of the rays (fig. 4 *A*) are narrowly lanceolate, the avenues have two rows of suckers, and the ambulacral plates support longitudinal bundles of spines, four or five in each fasciculus. External to these are regular, transverse rows of spines, supported on transverse ridges, eight or ten in each row. "The third series forms a bordering to the arms, and consists of sets of from eighteen to twenty long, fasciculated spines, placed on broad, compressed, articulated bases. The mouth is protected by a beautiful and peculiar mechanism. The angles formed by the joined origins of the rays each bear an ovate sub-triangular plate, grooved down the centre, and carrying two semicircles of long tapering spines, which project in a comb-like manner over the mouth."<sup>1</sup>

In the structure of the rays, the genus *Pteraster* resembles some remarkable fossil species. The tegumentary membrane on the convex upper surface is furnished with rows of short spines (fig. 5 *B*); the under surface has a biserial arrangement of tubular suckers in the ambulacra, and their margins are provided with numerous transverse fasciculi of spines, five or six in number, the spines of each fasciculus are connected together by a thin membrane, and

<sup>1</sup> Forbes, 'British Star-fishes,' p. 113.

form a series of fan-like structures (fig. 5 *A*) ; the borders of the rays are likewise armed with

FIG. 5.



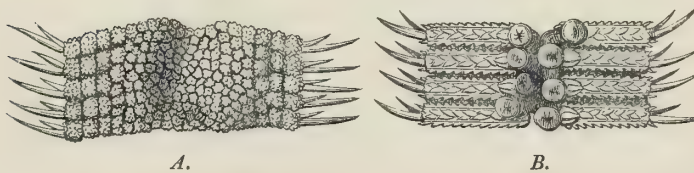
A portion of a ray of *Pteraster militaris*, M. and T.  
*A*, the under ; *B*, the upper surface.

long spines, extended transversely from the sides. These spines are connected by a fold of tegument, and united together like the ray-bones in the fin of a fish. Fig. 5, from Müller and Troschel,<sup>1</sup> who described this genus, from the North Sea, shows the regular disposition of these fan-like fasciculi of spines at the borders of the ambulacral valley, and the long transverse

spines at the margin of the rays, both classes of spines being in this genus connected together by prolongations of the common tegumentary membrane.

In *Luidia*, the body is stellate ; the rays are long, flat, and narrow, with a single row of ventral marginal plates supporting long spines ; the upper surface of the ray is

FIG. 6.



Portion of a ray of *Luidia Senegalensis*, M. and T. *A*, the upper ;  
*B*, the under surface.

closely set with paxillæ (fig. 6 *A*) ; the ambulacral valleys are narrow (fig. 6 *B*), the suckers biserial, and two sets of spines occupy the under side of the ray. The long, recurved spines on the margin of the rays, with the paxillæ covering their upper surface, ally this genus

to *Astropecten*. The toughness of the body and arms, in some star-fishes, is not more remarkable than their fragility in others ; and the difficulty attending the capturing of an entire specimen of *Luidia*, from its voluntary destructiveness, has been so graphically recorded by my lamented colleague, that I cannot do better than quote his account. "It is the wonderful power which *Luidia* possesses, not merely of casting away its arms entire, but of breaking them voluntarily into little pieces with great rapidity, which approximates it to the *Ophiuræ*. This faculty renders the preservation of a perfect specimen a very difficult matter. The first time I ever took one of these creatures, I succeeded in getting it into the boat entire. Never having seen one before, and quite unconscious of its suicidal powers, I spread it out on a rowing-bench, the better to admire its form and colours. On attempting to remove it for preservation, to my horror and disappointment, I found only an assemblage of rejected members. My conservative endeavours were all neutralised by its destructive exertions, and it is now badly represented in my cabinet by an armless disc and a discless arm. Next time I went to dredge on the same spot,

<sup>1</sup> Müller and Troschel, 'System der Asteriden,' p. 128.



determined not to be cheated out of a specimen in such a way a second time, I brought with me a bucket of cold fresh water, to which article star-fishes have a great antipathy. As I expected, a *Luidia* came up in the dredge,—a most gorgeous specimen. As it does not generally break up before it is raised above the surface of the sea, cautiously and anxiously I sunk my bucket to a level with the dredge's mouth, and proceeded in the most gentle manner to introduce *Luidia* to the purer element. Whether the cold air was too much for him, or the sight of the bucket too terrific, I know not; but in a moment he proceeded to dissolve his corporation, and at every mesh of the dredge his fragments were seen escaping. In despair, I grasped at the largest, and brought up the extremity of an arm, with its terminating eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision.”<sup>1</sup>

The *Goniasteridæ* have pentagonal bodies, flattened on both sides; the margin is bounded by two rows of large marginal plates, larger than those on other parts of the disc, and both entering into the formation of the border (figs. 7 *c*); their surface is variously covered with granules, spines, or pedicellariæ, and they are often encircled by granules. The upper surface of the disc and rays, within the marginal plates, is composed of small, flat, hexagonal, pentagonal, or tetragonal ossicula (fig. 8 *A*), and a like armature covers the under surface; the ambulacral avenues are bordered by a series of square ossicula, which are often marked with parallel grooves for lodging the spines (fig. 8 *B*). Towards the extremities of the rays (fig. 7 *d*), the dorsal border-plates are variously modified for lodging and protecting the eyes. Fig. 7, after Müller, represents *Astrogonium cuspidatum*, M. and T., laid open from above to show, *a*, the ambulacral plates; *b*, the inner surface of the inter-ambulacral plates; *c*, the upper border-plate; and *d*, the terminal plate, modified to protect the eye.

Fig. 8 shows the upper and under surfaces of a small *Astrogonium* in the British Museum Collection; *A* is the upper surface, exhibiting the large superior border-plates, enclosing the small polygonal discal plates with their granular circles, which occupy the whole intra-marginal upper surface; *B* shows the base, with the large inferior border-plates, and the

FIG. 7.

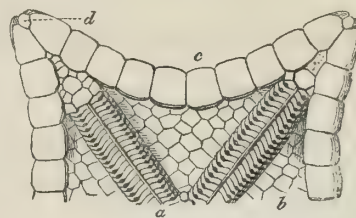
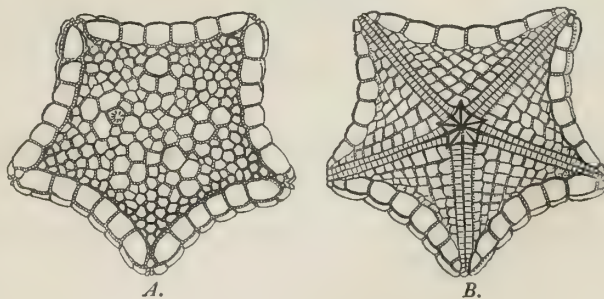
*Astrogonium cuspidatum*, M. and T.

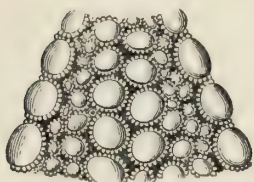
FIG. 8



<sup>1</sup> Forbes, 'British Star-fishes,' p. 138.

tesselated inter-ambulacral plates forming the floor of the rays, with the narrow ambulacral ossicles and the stellate mouth-opening.

FIG. 9.



Upper surface of a ray of  
*Astrogonium magnificum*, M. and T.

In *Astrogonium magnificum*, M. and T., the superior border-plates are encircled two thirds by rows of granules; and the upper surface of the arm is covered with large circular or oblong plates, smooth and convex on their upper surface, and each surrounded by a complete circle of granules. This structure is exhibited in the annexed figure 9, from Müller and Troschel.

FIG. 10.

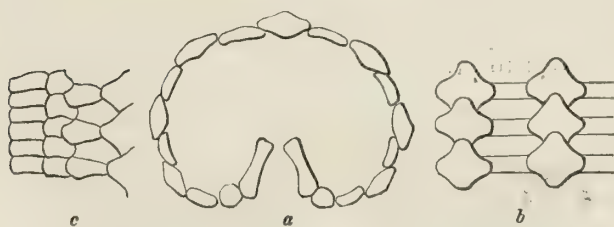


Under surface of a ray of  
*Stellaster Childreni*, Gray.

In the genus *Stellaster*, the upper and under sides of the pentagonal body are flat, and surrounded by two rows of large marginal plates, both of which enter into the formation of the high border; each of the lower marginal plates carries, near the outer side, a flat, moveable spine (fig. 10); and several granules are scattered over the surface. The ambulacra are narrow, and the suckers biserial; both sides of the intra-marginal disc are covered with granulated plates, on which numerous pedicellariæ are fixed. Fig. 10, which exhibits the under surface of one of the rays in *Stellaster Childreni*, Gray, illustrates the characters of this genus.

In *Ophidiaster* the rays are long, cylindrical, or conical; the osseous framework of each consists of a series of ossicula of two or three different forms; in this section of a ray (fig. 11) there are seven rhomboidal ossicula, of which three belong to the upper surface,

FIG. 11.



Section of a ray of *Ophidiaster*, with the inter-ambulacral plates.

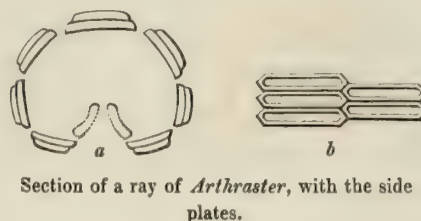
and two to each of the sides; eight oblong ossicula (*a*) unite the rhomboidal pieces (*b*) together, two uniting the rhomboidal ossicles of the upper surface of the ray with each other, two linking the superior lateral with the surface plates, two connecting the pairs of lateral rhombs of each side (*b*), and two articulating the inferior laterals with

the small, round ossicles which link the inter-ambulacral plates (*a*) with the long femur-like ambulacral ossicula projecting upwards into the interior of the arm (fig. 11 *a*). In this transverse section of a ray of an *Ophidiaster* we find nineteen ossicula, of which four or six belong to the ambulacral area, and the others to the inter-ambulacral portion. If the ossicula of an arm, therefore, were folded down, and extended outwards, the six ambulacra would form the centre, and the other plates on each side would represent the two halves of the adjoining inter-ambulacral areas.



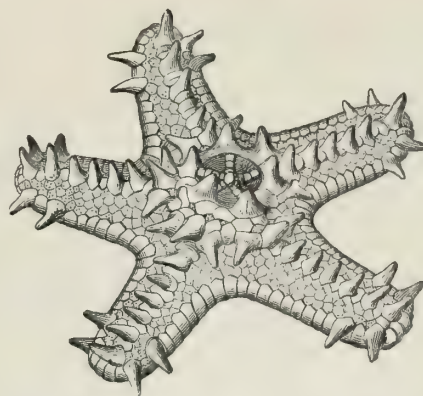
In *Arthraster* the number of the ossicula is less, and their arrangement different, than in *Ophidiaster*. This genus, which is cretaceous and extinct, has, according to Forbes, only seven ossicula in the framework of the ray, as shown in the transverse section, fig. 12 *a*, exclusive of the ambulacral bones, which are unknown. These plates are articulated together in such a manner as to form a compact armature surrounding the arms (fig. 12 *a*), like the plates and sutures in the test of *Echinidæ*, of which they are the homologues. All the seven ossicles are similar in form, each consisting of a transversely oblong, expanded, linear base, terminating in an acute angle at each end (fig. 12 *b*), and bearing along the centre a crest-like ridge with steep sides. The central ossicle is the largest, and this Forbes regarded as the equivalent of all the ossicles in the upper surface of the arm of *Ophidiaster* (fig. 11), whilst the others may be considered as the homologues of the lateral and ventral plates, with their connecting ossicula.<sup>1</sup>

FIG. 12.

Section of a ray of *Arthraster*, with the side plates.

The genus *Oreaster* comprises a group of pentagonal star-fishes, which have the under surface flat, and the upper surface more or less elevated; large tubercles or globular calcareous spines occupy various parts of the dorsal surface (fig. 13); the skeleton is formed of large plates, mostly of an irregular polygonal shape, which are disposed on the ridges of the arms in a more or less squamated order; the margins of the rays are surrounded by two rows of granulated plates, which overlap each other, the dorsal border-plate alone forming the margin, and the ventral border-plate lying on the under surface. There are two rows of tubular feet in each avenue, and a sub-central vent on the dorsal surface, which is elevated and sub-pyramidal (fig. 14). The interior of the test is strengthened by calcareous pillars, as in the *Clypeasters* among the *ECHINIDÆ*. The valve-like pedicellariæ are all sessile.

FIG. 13.

Upper surface of *Oreaster turritus*, Linck.

<sup>1</sup> 'Memoirs of the Geological Survey,' vol. ii, part 2, p. 467. See also Dixon's 'Geology and Fossils of Sussex,' p. 336, pl. 23, fig. 1.

*On the Homology of the Skeleton in the Asteriadae.*

Although the homology of the skeleton of the *Asteriadae* has long engaged the attention of naturalists, still upon this subject much diversity of opinion prevails, scarcely two of the classical authors holding the same views as to the relation existing between the test of a sea-urchin and the skeleton of a star-fish. Under these circumstances, I purpose giving copious extracts from the works of Delle Chiaje, De Blainville, Müller and Troschel, Agassiz, Müller, and Huxley, with the view of placing this interesting subject fairly before the reader.

*Osseous System.*

The inferior part of the rays in the *Asteriæ* (says Delle Chiaje),<sup>1</sup> or the whole of the rays in the *Ophiuræ*, is composed of a series of fragmentary and semicircular bones, almost similar to the vertebræ, the disposition of which deserves a special study (Cuvier, 'Rég. Anim.,' tom. iv, p. 9). The bones placed around the mouth are five in number; each of these is composed of four articulated parts; that is, two at the upper end, connected by useful teeth and corresponding ligaments, rounded at the bottom, and spinous; each of them, besides, is composed of as many (four) cylindrical, lateral bones, joined with the branches of the other four great vertebræ.

Thus for each ray there is a series quite decreasing, and each of them is made of two denticulated pieces, provided with ligaments, which have a hole underneath for the passage of the vertebral artery, and besides, of two faces connected with another spinous egg-shaped piece, which shuts the aperture in each ray; to these are fastened the feet, and in its inside are sometimes found two small annelides, one of which appears to me to be the same as the one described, although roughly, by the illustrious Baster (Opusc. subsec., tom. iv, fig. 9).

Some other imbricated spines, more or less short, are turned towards the sides of the ray, which at the lateral undermost part terminates in a long articulated spine, near which is found the hole for the passage of sea water, and by another smaller one lodged within the apex. Between this and the vertebra a long piece, according to the amplitude of the ray, articulates itself transversely. As in *Astropecten arantiacus*, the vertebræ are sufficiently large, so the ampullæ of the radial arteries fill up the entire space; whilst in *Echinaster echinophora* the vertebræ being smaller, the ampullæ fill up the space alternately. The uppermost portion of the ray is found likewise to be formed of a chain of osseous pieces, which are sometimes long and sometimes short. The same conformation is observable in *Uraster rubens*.

Besides the file of vertebræ in the rays of *Asterias exigua*, we notice between each of them many small cuneiform, imbricated bones, formed in the shape of as many triangles

<sup>1</sup> Memorie sulla storia e notomia Degli Animali senza Vertebre, vol. ii, p. 289. I am indebted to my friend, M. Ronna, for this translation from Delle Chiaje.



as there are spaces in each ray : in the angle at the vertex of this the osseous column is fastened to the superior integument, which appears to be perforated. The texture of *Asterias rosacea* is likewise entirely osseous.

The rays in the *Ophiuræ* have compressed vertebræ, orbicular, without any perforation, and with articular faces, as well as two furrows, one upwards and the other downwards. In the neighbourhood of the mouth, where they get larger, they support the two branches, of which the denticulated jaw is composed towards its end, and in *A. cordifera* (*Ophiolepis ciliata*) towards its basis. On the sides of the radii in *A. ophiura* (*Ophiolepis scolopendrica*) is noticed a couple of lamellated bones which are connected with the radii and with the epidermis : in case of this epidermis being deficient, as in *A. cordifera* (*Ophiolepis ciliata*), these sea'y bones are connected with its osseous and imbricated crust.

*Echinaster echinophora* has, moreover, many small bones, still smaller in *Uraster rubens*, which are articulated with the very small bones constituting the superior surface of the body. They correspond likewise with the axis of the moveable tubercles, acuminate in *E. echinophora*, rounded in *Asterias Savaresi*, and surrounded by the epidermis ; from these shoot out several muscular fibres, directed towards the respective osseous pedicellariæ, which, when looked upon through a magnifying lens, appear either to have an acuminate shape, or to be compressed and entirely rounded like the bill of a goose. Each pedicellaria is composed of two osseous, articulated pieces, fixed on a common basis of the same description. They enjoy the faculty of adhering to adjacent bodies, and keeping closely adhesive.

The small osseous chalices (or paxillæ) of *Astropecten arantiacus*, *A. bispinosa*, &c., are differently constituted. Each of these is a cylinder fastened at the bottom by means of strong muscular bands, the fibres of which have several intervening holes ; it ends at the top in a convex shape by many cylindrical pieces, distributed according to a double series, with internal articulations, and provided in the middle with a conical piece, excepting in *A. arantiacus* alone. It would be useless to enter into further minute details, which may be more easily traced out by an inspection of the purposely drawn-out figures in the tables.

De Blainville<sup>1</sup> says, the star-fishes have still a particular disposition of the external envelope, the dermis is more distinct than in the urchins ; we see better that solid and calcareous parts are developed in its interior. These parts form spines or scales more or less immoveable, and which present dispositions proper to each of the groups of this order.

In the *Asterias*, properly so called, that is to say, in the species in which the body is not provided with appendages, but which are divided more or less deeply into rays hollowed out inferiorly by a groove which extends throughout their entire length ; the superior parts have the skin sometimes soft, and oftener solidified by a greater or less number of irregular pieces arranged in a reticulate manner.

They are sometimes almost smooth, but in general are bristled with tubercles of

<sup>1</sup> De Blainville, 'Organisation des Animaux,' p. 213.



different sizes, disposed more or less irregularly, and which furnish excellent specific characters. The lateral and inferior parts are, on the contrary, sustained by a greater number of pieces, much more regularly disposed. They acquire sometimes a very great development, as in the *Asterias tessellata*, Lamk.; they appear to me always to form three series, one superior, the second altogether lateral, and the other inferior. It is these which unite with the series of pieces I call ambulacral, because it is between them that the tubular feet escape, as in the sea-urchins. The last two series of lateral pieces carry moveable spines; they are still the analogues of the inter-ambulacral areas of the sea-urchins; these spines vary, nevertheless, both as regards their figure and the number of rows which they form; they are always very singular for their resemblance to a grain of corn. As to the ambulacral pieces, they are very regular, very symmetrical, and they resemble in the median line of the inferior part of each ray a kind of spine, which sustains it, and which permits movements between its numerous articulations, as in a species of vertebral column.

Müller and Troschel,<sup>1</sup> in their 'System der Asteriden,' state, that the *Asteriadae* are Echinodermata of a stellate, or polygonal, mostly of a pentagonal form. In addition to the tegumentary skeleton, they possess an internal skeleton, which is wanting in all the others. This consists of as many rows of pieces moveably articulated together, as there are lobes in the body, and which always proceed from the circumference of the mouth, and from the under side of the rays. In the *Asterias* these rays form the floor of the abdominal furrows, and the tegumentary skeleton is supported in such a manner on the sides of the vertebral pieces of the internal skeleton as to form thereby hollow lobes, in which the intestines, or caecal prolongations of the stomach, and a part of the genital organs extend. In the *Ophiurae* the intestines are limited to the naked disc, and the articulated rows of the internal skeleton are everywhere surrounded by the tegumentary skeleton; so that the abdominal furrows are wanting in this group.

Professor Agassiz,<sup>2</sup> in the 'Catalogue raisonné des Échinides,' in treating of the affinities existing between the different orders of Echinodermata, combats the opinion expressed in the 'System der Asteriden.' "M. J. Müller affirms," observes M. Agassiz, "in his great work on the *Asteriadae*, that the character which most clearly distinguishes these animals from other Echinoderms consists in an internal skeleton, a kind of vertebral column, on which the solid plates of the external skeleton are fixed. He affirms, even, that we observe nothing similar in the Echinidæ, of which the solid framework is altogether external. But this assertion is erroneous, and the learned anatomist of Berlin appears to me to have completely misunderstood the analogy which exists between the ambulacra of sea-urchins and the grooves on the under side of the rays of star-fishes. This analogy is nevertheless the most complete, for we here remark the same arrangement of the plates, the same openings for the passage of the tubular feet, the same relations with the ocular

<sup>1</sup> 'System der Asteriden,' p. 1.

<sup>2</sup> 'Annales des Sciences Naturelles,' 3<sup>me</sup> série, tome vi, p. 309.

plate which is found at their summit, and with the masticatory apparatus which is found at their base. Notwithstanding the great number of the ambulacral plates, they likewise support this view of their comparative relations. As to the anal disc, it is much more extended; but this we can easily understand, if we recollect the extension which it presents, in the star-fishes, and the very narrow region circumscribed by the ocular and genital plates in the Echinidæ. The analogy of the star-fish and of the urchins is even so complete, that we may call the star-fishes urchins opened and flattened backwards, and, *vice versâ*, the urchins star-fishes contracted and inflated to form a sphere. This conformity of the urchins and the star-fishes makes me doubt the exactitude of observations which place the nervous filaments, which proceed to the eyes, at the inferior surface or external part of the ambulacra in the star-fishes, whilst they run along the internal surface of the ambulacral areas in the urchins."

In comparing the *Asteriadæ* and *Echinidæ*, as Blainville and Agassiz endeavoured to do, we soon perceive that the inter-ambulacral plates, observes Professor Müller,<sup>1</sup> instead of being analogous in the two orders, are quite differently arranged, and that on this circumstance in a great measure depends the difference between a sea-urchin and a star-fish. In the *Asteriadæ*, we must distinguish different kinds of inter-ambulacral plates from one another. Those which rest upon the external processes of the ambulacral plates have a certain peculiarity, as marginal plates of the ambulacra or *adambulacral* plates; they exactly agree in number with the ambulacral plates (fig. 7 a). To the second kind belong, in *Astrogonium* (fig. 7 c), the more or less well-marked *marginal inter-ambulacral plates* at the peripheral edge, which are sometimes in single, sometimes in double series. Between the ambulacral and marginal there are often *intermediate* inter-ambulacral plates (fig. 7 b). In *Astropecten* this area is exceedingly small, and is reduced to a few easily overlooked plates behind the angles of the mouth; in the pentagonal forms it is very large. In shape and size these plates often, as in *Astrogonium*, differ both from the adambulacral and from the marginal inter-ambulacral plates.

The marginal inter-ambulacral and the adambulacral plates extend to the end of the arms; the intermediate plates cease, for the most part, earlier. In those *Asteriadæ* whose arms are round, and whose margin is not developed, the series of plates which marks off the dorsal pore-area from the ventral surface is the equivalent of the marginal plates. In these forms, also, the number of the series of plates, from the groove of the arm to the pore-area, varies very greatly; in some there are only two series of plates, the intermediate plates disappearing, as in *Echinaster* and *Scytaster*, whilst in *Ophidiaster* there are many series of plates between the groove of the arm and the pore-area, the outermost of which, as adambulacral plates and marginal plates, extend completely to the extremity of the arm, the others, as intermediate rows of plates, are more or less, and, indeed, gradually, diminished. It is obvious that the inter-ambulacral plates of the sea-urchins

<sup>1</sup> 'Ueber den Bau der Echinodermen,' pp. 40, 42, 43.



and *Asteriadae* are differently, and, in fact, so differently disposed, as to give rise to the main distinctive peculiarities of a sea-urchin and of a star-fish.

Still greater are the differences between the ambulacra of the *Asteriadae* and *Echinidae* in the vertical direction. The nervous cord and the ambulacral canal of the *Asteriadae* lie, covered by the integument, over the mutually applied ambulacral plates, that is, upon the outer side of the vertebral processes of these plates;<sup>1</sup> in the *Echinidae*, however, they lie beneath the ambulacral plates on the inner surface of the shell. The vertebral processes of the ambulacral plates of the *Asteriadae* are absent in most *Echinidae*; but in the *Cidaridae* they have a perfectly analogous structure at the anterior extremity of the ambulacra, where the ambulacral plates on the inner side of the series of pores send off perpendicular processes into the cavity of the shell, between which lie the trunks of the ambulacral organs. The ampullæ are external. The clavate ends of a number of these processes unite to form a continuous colonnade, while they leave between their bases intervertebral passages, apertures for the branches given off by the ambulacral vessel to the ampullæ and the pores of the shell. There is no union of the vertebral processes of the right and left side. The analogy of the auricular processes at the anterior extremity of the corona of the sea-urchins with the vertebral processes of the *Asteriadae*, which is remarked in the "Anatomische Studien über die Echinodermen" ('Archiv.,' 1850), is more apparent than universally true. The auricular processes are, indeed, in most sea-urchins, processes of the ambulacral plates, and the ambulacral organs pass between them; but in *Cidaris* we meet with an exception, the inter-ambulacral plates giving off the auricular processes for the muscles of the jaws.

Besides *Cidaris*, *Clypeaster rosaceus*, and *altus* (or the genus *Echinanthus* altogether) possess that part of the ambulacral plates which is analogous to the vertebral processes of the *Asteriadae*, in the internal table of their ambulacral plates. In this case all the ambulacral plates take a part in its formation, and the right and left portions are even united by a suture. This ambulacral floor lies, as in the *Asteriadae*, beneath the trunks of the ambulacral vessels and nerves. On the other hand, the external table of the ambulacral plates lies over the trunks of the nerves and vessels, like the membranous covering of the ambulacra of the *Asteriadae*. Herein we have sufficient evidence that, in fact, the structure of the ambulacra in the *Echinidae* and *Asteriadae* is widely different, and *Cidaris* and *Echinanthus* may be considered to furnish the key to the proper understanding of these deviations.<sup>2</sup>

<sup>1</sup> I doubt the accuracy of this statement, for my dissections of *Uraster rubens*, Lin., showed that the course of the principal nerve of the ray was along the middle of the upper part of the ambulacra arches, the position homologous to that which the nerve occupies in the *Echinidae*, namely, beneath the ambulacral plates on the inner surface of the shell, as stated in the text by Müller.

<sup>2</sup> Johannes Müller, 'Ueber den Bau der Echinodermen,' 4to, plates, Berlin, 1854.

'Annals and Magazine of Natural History,' 2d series, vol. xiii, pp. 113-115. See a translation of parts of the above work by Professor Huxley, from which the above extract is taken.

“It is the *Asteridea*, *Ophiuridea*, and *Crinoidea*, known popularly as star-fishes,” remarks Professor Huxley, “which depart least from this common plan, the ambulacral and antambulacral regions being in all these about equally developed, and the arms in most cases distinctly marked off from the body. But there are certain star-fishes which are nearly pentagonal: suppose one of these, as Müller suggests, to be elastic, so as to be capable of being distended with air into a globular form; then the ambulacral region, with its five ambulacra, would occupy the entire apical hemisphere. There is no Echinoderm which exhibits this globular form, with equality of the ambulacral and antambulacral regions; but if we suppose the ambulacral region to increase at the expense of the antambulacral, so that the latter eventually became reduced to a very small space around the apex, the result would be the form of *Echinus*, or of *Holothuria*, in which the ambulacral region greatly predominates, the arms disappear, and the ambulacra are, consequently, entirely calycine. One moiety of the *Cystideæ* are in the same predicament; but other *Cystideæ*, such as *Echino-encrinus*, *Prunocystites*, *Cryptocrinus*, present a precisely opposite condition, the antambulacral region here extending into the close vicinity of the mouth, and greatly predominating over the ambulacral region. In the *Blastoidea* again, the antambulacral and ambulacral regions are more upon an equality, but the body is sub-cylindrical or prismatic in shape; otherwise they would offer a close approximation to the hypothetical form, intermediate between an *Echinus* and a star-fish, mentioned above.”<sup>1</sup>

Having thus reviewed the opinions advanced by different authors on the homology of the skeleton of the ASTERIIDÆ as compared with the test of the ECHINIDÆ, it only remains for me to state as briefly as possible the views on this subject which I have for nearly thirty years been in the habit of teaching in my lectures on comparative anatomy. I regard the valley in the centre of the under side of the rays in star-fishes, through which the tubular retractile feet pass, as homologous to the ambulacral areas and poriferous zones in the ECHINIDÆ; the ossicula forming the sides and upper surface of the rays of the star-fish as the homologues of the inter-ambulacral plates of the ECHINIDÆ, greatly modified for a special function. In order to show the relation of these parts to each other, I take a moderate-sized *Uraster rubens*, Lin., dead some hours, and quite flaccid, and dissect out a circle of the integument in the centre of the upper surface of the disc, including therein the madreporiform tubercle, vent, and genital pores; the part thus removed will represent the anal area. With a pair of scissors I then lay open the upper surface of all the rays by a straight incision down the middle, from the circumference of the anal circle to the extreme point of the ray, and, folding down the two flaps thus produced from each ray into the inter-radial spaces, with a needle and thread sew the lateral flaps from the adjoining rays together; when the whole of the flaps are thus united, I raise the border of the flat disc and form the whole into a globular shape, taking care to make the extreme points of the rays, with their eye-spots, touch the margin of the anal circle, which must be

<sup>1</sup> ‘Medical Times and Gazette,’ new series, No. 332, p. 463.



elevated likewise to a sufficient height, by cutting across the sand canal and other adhesions to meet the ends of the rays, and thereby form a globe. When the parts are all thus adjusted, it will be seen that they hold the same relation to each other in the ASTERIADÆ as they do in the test of the ECHINIDÆ. Thus the two flaps from each ray, when united by suture with the flaps from the adjoining rays, represent the wide inter-ambulacral areas, with their zigzag sutures in the centre, and the surface of both being armed with spines increases the analogy. The narrow ambulacra, with their two or four rows of suckers, are undoubtedly the homologues of the ambulacral areas and poriferous zones in the *Echinidæ*. The anal area, containing the madreporiform tubercle, genital pores, and the vent, in star-fishes, represents the apical disc formed by the ovarian plates, anal opening, and madreporiform body, in urchins. The five eye-plates at the ends of rays, in star-fishes, will fit into the margin of the circular area, when the extremity of the rays are made to approximate this part, by folding up the flat disc and converting it into a globe, which is the same singular position they occupy in the test of the *Echinidæ*. The mouth-opening will be obviously the same in position in the under side of the body in both orders.

If this demonstration is satisfactory, it is clear that we must not seek the homology between the star-fish and sea-urchin by inflating the body of disciform species, and thus making them assume globular forms, as suggested by Müller, but by placing the homologous parts in the same relation they hold to each other in these two orders of Echinodermata, always recollecting that the test of the *Echinidæ* forms a hollow globe in which the viscera are enclosed, whilst the skeleton of the *Asteriadæ* is a stelliform disc, into each ray of which a portion of the viscera is prolonged. By incising the rays down the centre of their upper surface, and folding down and uniting by suture their sides together, we produce, very clumsily it is true, the same conditions so beautifully provided in the *Echinidæ*, and reduce to a demonstration the homology of the several parts of which the body of the star-fish is composed. I have selected *Uraster rubens* for illustration, because the flexibility of the rays enables one to operate upon it easily with the scissors; but if my reasoning is correct, the observations which apply to this species will hold true with all the others, if they admitted of similar anatomical manipulation.

#### *The Madreporiform Body.*

The ASTERIADÆ, in common with the ECHINIDÆ, possess a madreporiform body; which is situated in an excentral position on the upper surface, between two of the rays (fig. 13). From the spongy plate a canal descends towards the mouth. In the *Echinidæ*, the madreporiform body always occupies the right antero-lateral ovarian plate; and as I have shown that the single ambulacral segment represents the anterior part of the body in the sea-urchins, for this reason it is inferred, that the single ray to the left of the madreporiform body in the species possessing a single plate forms the homologous part of the animal in the star-fishes.

In all the ECHINIDÆ the madreporiform body is single, and rests on the upper surface of the right antero-lateral ovarian plate; sometimes, however, it extends over the other elements of the apical disc, and surrounds them with its spongy structure. In the ASTERIIDÆ the madreporiform plate is likewise for the most part single, but there are many species in which two, three, or more plates are found. It has been assumed that an increase in the number of the plates bears a certain relation to the number of the arms; observation, however, has proved that this is not the rule in all the many-rayed forms. *Solaster* and *Luidia*, for example, which possess numerous rays, have the madreporiform plate single, whilst in some five-rayed *Ophidiasters* the plate is double. With an increased number of arms there is, in some genera, a corresponding increase in the number of the madreporiform plates. Thus, in *Asterias Helianthus*, Lamk., which has from thirty to thirty-six rays, the madreporiform plate consists of many pieces; and *Uraster tenuispina*, Lamk., which has from six to eight rays, possesses two or three plates. The genera *Ophidiaster* and *Echinaster*, in general, have more than one plate. In *Ophidiaster multiforis*, Lamk., the individuals with five rays have two plates, whilst those with six rays have three; and in *O. diplax*, *O. ornithopus*, *O. Ehrenbergii*, all five-rayed species, there are two plates in each. The remarkable *Echinaster solaris*, so beautifully figured by Ellis,<sup>1</sup> has twenty short rays armed with very long spines, and around the circumference of the anal area sixteen hemispherical, madreporiform plates are figured; in other individuals of the same species, examined by Müller and Troschel,<sup>2</sup> the number of plates was not so great; one specimen with fourteen rays had five, and another with sixteen rays had six plates; and *Echinaster Eridanella*, Valenc., with six rays, has two madreporiform plates. In those genera, therefore, the number of the plates appears to augment with the number of the rays.

#### *The Tegumentary Appendages.*

The tegumentary membrane in the ASTERIIDÆ is provided with different kinds of appendages, as *spines*, *granules*, *paxillæ*, and *Pedicellariæ*, each of which requires a separate notice.

The *spines* are calcareous pieces of various forms and sizes; they are in general attached by their base, and often destitute of the kind of articulation seen in the spines of ECHINIDÆ. In *Uraster*, Pl. I, fig. 2, they are sharp, prickly processes arranged in rows, with more or less regularity, along the upper surface, sides, and base of the rays. In *Astropecten* (fig. 3) and *Luidia* (fig. 6), they are in the form of long, tooth-like spines which project from the sides of the marginal plates. In *Pteraster* (fig. 5) they fringe the borders of the rays, form fan-like semicircles near the ambulacra, and arm the upper

<sup>1</sup> 'Natural History of Zoophytes,' p. 206, Pl. 60, 61, 62.

<sup>2</sup> 'System der Asteriden,' p. 25.



surface of the lobes with thorny prickles. In *Echinaster* they are developed into long defences, and thickly set together on all the surface of the body. In *Oreaster* (fig. 13) they are thick calcareous pieces, which rise in various forms from the surface of the ossicles. In *Astrogonium equestris* the smooth spines project from the centre of a nearly circular plate, around the border of which is a circle of granules; the intermediate spaces are filled with tubercles, among which valve-shaped *Pedicellariæ* are scattered (fig. 8). Besides the spines disposed on the sides and upper surface of the rays, there are others which, in general, have a very regular arrangement, and form consecutive rows on each side of the ambulacral valleys.

The *granules* are fine, calcareous, wart-like processes, which grow from the surface of the integument, and cover all the rays in *Ophidiaster* and *Scytaster*. In other genera they are much more limited in their distribution, and occupy the inter-spinous spaces on the surface of the rays.

The *paxillæ* are formed of processes of the integument, which rise like short stems in regular order from the surface of the ossicles; each stem carries a crown of short, bristly spines, as in *Solaster* (fig. 4). In *Scytaster* they are distributed over the discal membrane, and arranged in lines on the sides and upper surface of the rays. In *Astropecten* (fig. 3), *Luidia* (fig. 6), *Ctenodiscus*, and *Archaster*, they fill the entire space on the upper surface within the area circumscribed by the marginal plates.

The *Pedicellariæ* are small, pincers-like bodies, supported on slender, flexible stems, and found in considerable numbers around the bases of the spines and on the membrane surrounding the mouth. They were first observed by Müller<sup>1</sup> on the test of a sea-urchin (*Echinus sphæra*), and described by him as *Epizoa*. Lamarck<sup>2</sup> classed them with the Polypes, and Cuvier<sup>3</sup> doubtfully adopted the same view, as also Schweigger;<sup>4</sup> whilst Munro, Oken, Delle Chiaje, Sharpey, Valentine, Sars, Müller and Troschel, and Forbes considered them as tegumentary appendages of the animals on which they are found.

In *Uraster rubens*, Lin., groups of these pedicellated, pincers-like bodies are seen clustering around the base of the spines, each consisting of a membranous stem, surmounted by a pair of calcareous forceps not unlike the miniature claw of a Crustacean; when alive and active, if a fine needle is introduced between their expanded blades, they close upon the foreign body, and grasp it with force. Professor Forbes<sup>5</sup> examined the *Pedicellaria* in this star-fish, and observed that "those on the body and upper spines differ in shape from those on the spines which are arranged on the sides of the ambulacral valleys. The former are much shorter and blunter in their blades than the latter. The calcareous forceps of which their heads consist are imbedded in an integument of a soft, granular

<sup>1</sup> 'Zoologia Danica.'

<sup>2</sup> 'Animaux sans Vertèbres,' 1st ed., vol. ii, p. 63.

<sup>3</sup> 'Règne Animal,' 2d ed., vol. iii, p. 297.

<sup>4</sup> 'Handbuch der Naturgeschichte.'

<sup>5</sup> 'History of British Star-fishes,' p. 98.

tissue, which envelops the forceps when closed ; and this apparatus is mounted on a bulging body of a similar substance, which crowns the round, flexible, and contractile peduncle, sometimes simple, sometimes branched, each branch having a similar termination. I could detect no evidence of vibratile cilia on their stalks ; but there appeared to be ciliary motions within the blades. When the star-fish is alive, the *Pedicellariæ* are continually in motion, opening and shutting their blades with great activity ; but when cut off, they seem to lose their power." The *Pedicellariæ* observed on certain Echinodermata have been most carefully examined by Sars,<sup>1</sup> and I shall enrich this branch of the subject with that accomplished naturalist's observations on these remarkable appendages of the tegumentary membrane.

"In examining *Echinus sphaera*," says Sars, "I found upon it all the three sorts of *Pedicellaria* described by Müller, viz., *P. tridens*, *P. triphylla*, and *P. globifera*. Besides what Müller states in regard to *P. tridens*, I will make the following remarks :—Internally, there is a hard stem, which is enclosed by a strong, transparent skin, like a sheath. It is thickest at the upper and lower ends, and reaches from the neck, as it is called, to the base, where it, remarkably enough, is fixed and jointed to an exceedingly small barb projecting from the sea-urchin's shell. This circumstance, which is invariable in the *Pedicellaria*, seems not to have been sufficiently attended to. The three teeth are concave on the side, turned inwards, angular, and furnished with small teeth on their edges. They are hard and calcareous ; when viewed through a microscope, they are seen connected with very small globules arranged in rows. The stem is also calcareous, yet it can be slightly bent without breaking. The neck is nearly as thick again as the stem ; it is fleshy, transparent, and very flexible.

"The motions observed in the *Pedicellariæ*, when irritated, are that the teeth close and squeeze pretty firmly ; in this way, by inserting the point of a pin between them, after the *Pedicellaria* was torn off, I could draw it out of the water ; further, that the neck bends and inclines to all sides, and can even contract a little, in doing which transverse wrinkles are formed on it ; and, lastly, that the stem, itself inflexible, may bend along with the whole *Pedicellaria* to the side. The form called *Pedicellaria globifera* by Müller has a head consisting of three outspread flaps, standing nearly horizontally. Each of these flaps is oval, very convex externally, and concave internally, and at the upper end slightly indented, and provided with a sharp point, somewhat bent. From the indentation runs a raised stripe or rib longitudinally downwards through the flap. On the inner side of these flaps, at their base, is seen an oval and apparently calcareous leaf.

"The stem, which is similarly constituted with that of *P. tridens*, proceeds directly from the head (there is no neck in this species), is small above, and thicker below, until at the bottom it completely fills the hollow of the sheath which encompasses it.

<sup>1</sup> 'Ueber die Entwicklung der Seesterne.'—Müll. Arch. 1842, p. 330. 'Ueber die Entwicklung der Seesterne.'—Wieg. Arch., 1844, ii, p. 169, fig.



“ With regard to the motions of these *Pedicellariæ*, they not only quickly open and shut the three flaps, but can also turn the head to the different sides, and up and down, and that very quickly.

“ Müller says, regarding *P. tridens* :—‘ Variat absque aristis, an perditis?’ Of such I have also found a large number of specimens ; but I scarcely believe that they belong to *P. tridens*, since the teeth of these last are fixed so firmly that they could scarcely fall off. Either they are a separate species or a variety of *P. triphylla*, which they resemble in every point, except that the three flaps are broad at the bottom and small at the ends. These flaps seemed there also to be calcareous, and consisted of many small globules, which were arranged in transverse rows, clearly separated from each other by a light transparent line. Such a line also ran longitudinally down the flap. In *P. triphylla* the flaps are not obtuse, but a little rounded, and have, like the foregoing, globules extending in rows. If we now consider the construction of the *Pedicellariæ* and their manner of life as a whole, we can scarcely believe them to be anything but organs of the sea-urchin.”

The following reasons seem to prove the accuracy of this opinion :

“ 1st. In all sea-urchins, without exception, are found *Pedicellariæ*, and under the same circumstances ; which would certainly not always be the case if they were parasitical animals,—just as *Lernææ* are not always found in all fishes, &c.

“ 2d. The hard calcareous teeth or plates, and the internal stem, also calcareous, and often filling up alone the sheath, which are found in all *Pedicellariæ*, bear a greater resemblance to an Echinus spine than to any animal of the Polype kind. There is neither opening, nor mouth, filaments, &c.

“ 3d. The *Pedicellariæ* are firmly fixed in the skin which envelops the whole sea-urchin, upon a very small projecting knob of the shell, to which knob they are very strongly attached, but yet moveable, like the prickles of the sea-urchin ; the under surface of the stem of a *Pedicellaria* being somewhat hollowed and articulated with the knob. When a *Pedicellaria* is torn out, it is observed that the sheath or skin connecting the stem is torn at the lower end, which, doubtless, is a consequence of its connection with the skin, with which the shell of the sea-urchin is covered, and which, when the *Pedicellaria* is torn out, must be rent.

“ 4th. When the skin of the sea-urchin or a single *Pedicellaria* is irritated—for example, with a pin—the surrounding *Pedicellariæ*, which stand in a wide circle, invariably bend themselves quickly towards the irritated part. This phenomenon, which I have often observed, shows clearly an organic connection between the *Pedicellaria* and the skin of the shell of the sea-urchin.

“ The same thing precisely is observed with the spines.”

On the use of these bodies, M. Sars continues : “ Perhaps Nature, who has so abundantly provided the sea-urchin with such an astonishing number of feet and prickles, has also given the *Pedicellariæ*, as a sort of antennæ to seize the small animals which serve for its sustenance, partly to lay hold of whatever might approach their sensitive skin which covers

the surface of the shell, and thus, in conjunction with the prickles, protect it from injury." Professor Edward Forbes, in discussing the function of the *Pedicellariæ*, says, "If they be not distinct animals, as Müller fancied, for what purpose can they serve in the economy of the star-fish? If they be parasites, to what class and order do they belong?—what is their nature, and what is their food? Truly, these are puzzling questions. These organs or creatures have now been known for many years, have been examined and admired by many naturalists and anatomists, have been carefully studied and accurately delineated, and yet we know not what they are. This is but one of the mysteries of natural history—one of those unaccountable things which we know and know not—of those many facts in nature which teach us how little is man's knowledge, and how wondrous and unsearchable is God's wisdom. It is folly and vanity to attempt to account for all facts in nature, or to pretend to say why the great Creator made this thing, and why He made that, and to discover in every creature a reason for its peculiar organization. It is but another form of the same vanity, having satisfied itself of the discoveries it has made, to pretend to praise the all-wise Maker's wisdom in so organizing His creatures. That God is all-wise is a revealed truth; and whether the organization before us seem excellent or imperfect, it matters not—we *know* it is perfect and good, being the work of an all-wise God."<sup>1</sup>

### *The Vent.*

It was long believed that the *Asteriadae* were destitute of an anal opening, but a more careful study of the organization of these animals has proved this was an error. Baster,<sup>2</sup> in reference to *Uraster rubens*, wrote:—"Utrumque genus (Echinorum et Stellarum marinarum) os inferne, et ad excrementa ejicienda aperturam superne habent."

Janus Plancus<sup>3</sup> observed:—"Præterea hæ stellæ anum in medio oppositum ori, uti Echini, veluti umbilicum quemdam gerunt et in acumen attollunt." Müller<sup>4</sup> describes, in the *Asterias militaris*, a central spot as "macula verruciformis," and says as this spot is not perforated, therefore Baster's description of the anus could not be correct.

Tiedemann, in his great work, denied Baster's statement, and treated his observation as a mistake; since the publication of that treatise, the same opinion has been expressed in nearly all modern zoological works. This discrepancy about an anatomical fact has arisen from the error of deducing general conclusions from limited observations; for it now appears that, of the eighteen genera of star-fishes described by Müller and Troschel

<sup>1</sup> Forbes, 'British Star-fishes,' p. 98, 99.

<sup>2</sup> Baster 'Opuscula subseciva,' p. 116.

<sup>3</sup> 'Epistola de incessu marinorum Echinorum. Opuscula Instituti Bononiensis,' tom. v, pars i, p. 245.

<sup>4</sup> 'Zoologia Danica,' cxxxi, p. 14.



fifteen of these possess a vent, and only three are destitute of that aperture. The

FIG. 14.



A portion of the disc, with the vent in *Oreaster reticulatus*.

star-fish which Tiedemann dissected and illustrated with magnificent plates (*Astropecten aurantiacus*, Lin.) belongs to the latter group; whilst Baster's observations were made on *Uraster rubens*, Lin., which is classed with the former, and possesses an anal opening. The vent is sub-central, and lies in general at the left side of the madreporiform plate, sometimes surrounded, as in *Oreaster reticulatus*, by a circle of small wart-like tubercles. The annexed fig. 14 shows the size and position of the vent aperture in this large star-fish.

### STRATIGRAPHICAL DISTRIBUTION OF THE FOSSIL ASTERIADÆ.

It was long supposed that the *Crinoideæ* were the only representatives of the Echinodermata in the Palæozoic rocks, but recent researches in the Silurian strata of England, Wales, Ireland, and North America, have led to the discovery of *Asteriadæ* in several stages of these ancient formations. Professor Sedgwick and Mr. Salter, in 1845, found *Palæaster obtusus*, Forb., in the ash-bed west of Bala Lake, and the same species was afterwards discovered in 1846 by Sir Henry de la Beche, Captain James, R.E., and Professor Forbes, in the fossiliferous slates of Drumcannon, near Waterford, which are of Bala and Caradoc age, as shown by the fossils of all their fossiliferous portions. The Lower Silurian rocks of North America have likewise yielded *Asteriadæ*. Mr. James Hall has described and figured *Palæaster Niagarensis*, Hall, from the Trenton limestone of the State of New York, and Dr. Billings has described many new forms from the Lower Silurian rocks of Canada, and figured the same in the third decade of Canadian organic remains of the 'Geological Survey of Canada.'

The Upper Silurian strata of Westmoreland and Shropshire have likewise lately been found to contain some beautiful little sea-stars in fine preservation, and Mr. James Hall has discovered several new forms in the Upper Silurians of the United States.

The Palæozoic *Asteriadæ* have been studied with great care by the late Professor Forbes, Mr. James Hall, Mr. Salter, and Dr. Billings. All the species belong to extinct genera, which present many singular modifications of structure, and afford interesting points of comparison with some living forms. The following genera have been proposed for the reception of these Palæozoic *Asteriadæ*; the diagnosis of each is given in the words of their respective authors.

*Genus* 1. *PALÆASTER*, Hall.—Arms thick, convex, short, or moderately elongate, and formed of many rows of small, spinous ossicles on the upper surface; ambulacra deep,

with transverse ossicula, and a single row of adambulacral plates. No disc plates between the rays; madreporiform tubercle small and single. This genus ranges from the Lower Silurian to the Carboniferous strata.

*Genus 2. PALASTERINA, M'Coy.*—Pentagonal depressed; the arms a little produced, with three or five principal rows of tubercles above, combined with a plated disc which fills up the angles; ambulacra rather shallow, formed of subquadrate or slightly transverse ossicles, bordered by a single row of large, square-shaped plates, the lowest of which are large and triangular, and support combs of spines. Upper Silurian rocks.

*Genus 3. STENASTER, Billings.*—No disc; rays linear, lanceolate, or petaloid; ambulacral grooves bordered by solid, oblong, or square adambulacral plates; five pairs of triangular oral plates; two rows of ambulacral pores. Upper surface of the disc and rays covered with small plates, which appear to be tubercular, and not closely fitted together. The generic name is from *stenos*, narrow, in allusion to the contracted body. Lower Silurian.

*Genus 4. PETRASTER, Billings.*—This genus has both marginal and adambulacral plates, with a few disc-plates on the ventral side. The general form is deeply stellate, and the rays are long and uniformly tapering. Generic name from *petra*, a stone. It differs, according to Dr. Billings, from *Palasterina* by the presence of large marginal plates outside of the disc-plates, and still more from *Stenaster*, which has neither discal nor marginal plates. It is, however, allied to *Astropecten*. Lower Silurian.

*Genus 5. PALÆOCOMA, Salter.*—Flat; all the centre of the disc above membranous, with scattered, star-like calcareous spiculæ; the angles filled up with a similar membrane. Arms formed of several rows of quadrate, reticular ossicles, the external rows fringed with spines. Beneath, the ambulacra are narrow and very shallow, the ossicles square or even elongate, and placed alternately. Two rows of bordering plates, the inner row square and without spines, the outer row oblique and fringed with combs of very long spines; a loosely reticulated membranous web between the arms. Upper Silurian.

*Genus 6. PROTASTER, Forbes.*—Arms elongate, extending much beyond a circular, closely reticulated disc. Arms formed above of two rows of plates, deeply sculptured and spinous at the edge; beneath, of two rows of elongate ambulacral ossicles, bordered by a row of large spinous plates. The basal ossicles of the ambulacra, bordering plates, and disc, combined to form a petaloid mouth below. Upper and Lower Silurian rocks.

*Genus 7. PALÆODISCUS, Salter.*—Arms not produced beyond the large, *plated* pentagonal disc, nor distinguishable from it above; ambulacra formed beneath of crowded,



transverse ossicles, the basal joints of which are greatly enlarged, thickened, and placed in vertical pairs to form the mouth.

*Genus 8. TÆNIASTER, Billings.*—Body deeply stellate; no disc or marginal plates; rays long, slender, flexible, and covered with small spines; two rows of large ambulacral pores; adambulacral plates elongated and sloping outwards so that they partly overlap each other; adambulacral ossicula contracted in the middle, dilated at each end. Generic name from *tænia*, a ribband.

*PALÆASTER.*—*Hall.*

*Palæaster asperrimus*, Salter (Annals and Mag. of Nat. Hist., 2d series, vol. 20, p. 325, pl. ix, fig. 1) fig. 15<sup>1</sup>.

Rays five, short, round and obtuse; upper surface convex (1), and ornamented with many longitudinal rows of prominent tubercles; a single madreporiform body at the angle between two rays. Ambulacra wide; grooves deep, bordered by two rows of large, transverse, marginal, adambulacral ossicula, with acute ridges on their under side (1 a).

*Locality.*—Collected by the Geological Survey in the Caradoc or Bala sandstones, near Welchpool, N. Wales.

*Palæaster obtusus*, Forbes. Mem. Geol. Surv., Decade 1, pl. i, fig. 3, 1849.

“Body rather broad, convex above, spinosely reticulated; spines very short, and probably grouped in tufts. The arms are short, convex above, broad, oblong, and obtuse. Their under surfaces exhibit oblong, rather broad, ambulacral plates, gradually decreasing in size towards the tips of the arms, but nearly equal for about two thirds of their length; the ambulacral sulcus between them is rather broad. The largest specimen examined measured an inch and a half across.”

*Locality.*—First found in Lower Silurian rocks at Drumcannon, near Waterford, in 1846, by Sir Henry de la Beche, Captain James, R.E., and Professor Forbes, and by the Geological Surveyors in the ash-bed of the Bala rocks, West of Bala Lake, North Wales. In the Irish locality it was associated with *Phacops Jamesii* and numerous *Orthides*. In the Welsh, with Trilobites of the genera *Asaphus*, and *Homalonotus*. Brachiopoda of the genus *Orthides*, and numerous stems of *Encrinites*.

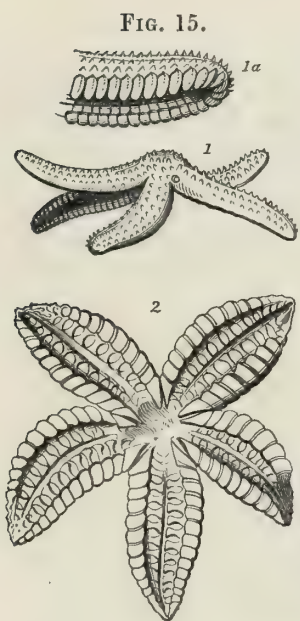


Fig. 1. *Palæaster asperrimus*, Salt.  
Fig. 2. *Stenaster Salteri*, Billings.

*Palæaster coronella*, Salter. Ann. and Mag. Nat. Hist., 2d series, vol. xx, p. 326.

“A small species, with four rows of tubercles on each arm, and a close corona of six tubercles.”

*Locality*.—Gunwick Mill, Malvern (in the May Hill Sandstone).

*Palæaster Ruthveni*, Forbes. Mem. Geol. Surv., decade i, pl. i, fig. 1.

“Body very small, in the centre of five tapering linear lanceolate, rounded rays, subcarinated on their upper surfaces, five times as long as the disc is broad. The upper surfaces of both rays and disc are reticulated, indicating a structure which originally, in all probability, consisted of spines grouped in tufts. The under surfaces are marked by the impressions of a double series of ambulacral articulations, each slightly curved. Both these structures are present in some existing antarctic forms of *Uraster*. The largest specimen examined measured three inches and a half across, from arm-tip to arm-tip.”

*Locality*.—At Scalthwaiterigg, and Highbarn, Westmoreland; in Ludlow Rocks. The original specimen is in Professor Sedgwick's collection.

*Palæaster hirudo*, Forbes. Mem. Geol. Surv., decade i, pl. i, fig. 4.

“Body very minute, about a fourth as broad as the rays are long; rays tapering and linear-lanceolate, contracted at their bases, pointed at their extremities. Their upper surface clothed with bundles of spines arranged in regular rows, and so placed that each ray seems to be marked by three or four longitudinal furrows, crossed at regular intervals by transverse grooves. Under surface with short ambulacral plates and broad avenues. The largest specimens do not measure more than an inch across.”

*Locality*.—Gregarious in Ludlow Rocks, at Pottersfell, near Kendal, Westmoreland.

*Palæaster Niagarensis*, Hall. Palæontology of New York.

Body stellate, arms tapering, ambulacra wide, under surface of the rays with large marginal adambulacral plates, and five oral plates.

*Locality*.—Trenton Limestone, Lower Silurian series, New York.

A small *Palæaster* has been found at Braunton, near Barnstaple, N. Devon, in the



lowest beds of the carboniferous rocks ; these beds, Mr. Salter kindly informs me, are called by Mr. Jukes and himself the "Coomhola grits" in Ireland, and which Sedgwick and Murchison called the "Marwood beds" in N. Devon : they are neither Devonian nor Carboniferous, but lie on the confines of both. This asteroid is not yet described.

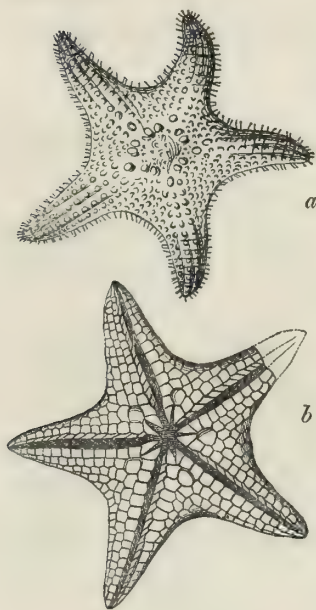
PALASTERINA, *McCoy*.

*Palasterina primæva*, Forbes. Mem. Geol. Surv., decade i, pl. i, fig. 2.

— — — Salter. Ann. and Mag. of Nat. Hist., 2d series, pl. ix, fig. 2,  
from which fig. 16 *a* is copied.

Body broad, pentagonal, produced at the angles into five short, lanceolate, or elongato-

FIG. 16.



*Palasterina primæva*, Forbes, fig. *a*.  
„ *stellata*, Billings, fig. *b*.

triangular, pointed arms, which are each about two thirds as long as the breadth of the disc. Surface of the disc convex above (*a*), as well as the arms tuberculated and reticulated, exhibiting traces of having been covered by tufts of short, blunt spines. Madreporiform plate and vent, both subcentral. Beneath, nearly flat ; the inter-ambulacral spaces reticulated like the upper surface ; the ambulacra composed of broad, oblong, geniculated plates (*b*), of which there are about twenty in a row. The largest specimens examined had attained the dimensions of an inch and a half in diameter, from arm-tip to arm-tip. This star-fish has many affinities with *Asterina* or *Asteriscus*. Mr. Salter has discovered that the "basal or angle ossicula are enlarged, three-cornered, and furnished with a pyramid of spines, pointed inwards. The upper surface is roughly tuberculate, and possesses short tufts of spines."

*Locality*.—Underbarrow, near Kendal, Westmoreland. It is found in a thin, subcalcareous band of Ludlow Rock, loaded with *Trilobites* and *Encrinites*.

*Palasterina antiqua*, Hisinger. Leth. Suec., tab. xxvi, fig. 6, p. 89.

*Locality*.—Mount Hoburg, Gothland, Sweden ; in Ludlow Rocks.

The Canadian species of *Palasterina* I have derived from Dr. Billings' valuable paper on the *Asteriadae* of the Lower Silurian Rocks of Canada, in the third decade of Canadian Organic Remains.

*Palasterina stellata*, Billings. Geol. Surv. of Canada, Organic Remains, decade iii, pl. ix, fig. 1, p. 76. Fig. 16 *b* copied from this plate.

*Description*.—Pentagonal; disc about one half of the whole diameter; ambulacral grooves narrow and deep, bordered on each side by a row of small, nearly square adambulacral plates; a second row, consisting of disc-plates, extends nearly to the end of each ray, the remainder of the disc covered with smaller plates. All these plates are solid and closely fitted together; the disc-plates in the angles in contact with the oral plates are much larger than any of the others (fig. 16 *a*).

In the only specimen in the collection, the length of the rays, measured along the ambulacral grooves, is three lines; number of adambulacral plates on each side of the grooves, sixteen; the rays diminish somewhat rapidly in size, and terminate in a rounded point; diameter of the disc four lines. The plates are all a little worn, so that the character of their surfaces cannot be observed; they were probably nearly smooth.

*Locality and Formation*.—City of Ottawa; Trenton Limestone. Collected by Dr. Billings.

*Palasterina rugosa*, Billings. Geol. Surv. of Canada, Organic Remains, pl. ix, figs. 2 *a, b, c.*, p. 77.

*Description*.—Two inches in diameter; rays five, acute at their apices, and rapidly enlarging to a breadth of four lines at the disc, which is eight lines in width. The specimen shows the upper side of the fossil only. Some of the plates are absent from the centre of the disc, but those which remain are very prominent in their centres, and roughly ornamented with four or five deep crenulations or furrows from near the centre to the edges, producing a star-like appearance, resembling a half-worn plate of *Glyptocrinus decadactylus*; their diameter is from one to two lines.

The rays are composed (at least, the backs and sides of them) of four rows of plates, which are so very prominent that they appear to be almost globular, and even pointed in their centres; the central rows are the smallest; the first four plates of the outer row occupy three lines in length, and of the inner rows nearly as many. Towards the point of the arm all diminish rapidly in size. Beneath the outer rows two others can be seen, which are probably the outer marginal plates of the under side, corresponding to those of *P. rigidus*.

*Locality and Formation*.—Charleton Point, Anticosti; Hudson River group. Collected by J. Richardson.

<sup>1</sup> 'Geological Survey of Canada.' Canadian Organic Remains, decade iii, p. 76, pl. ix, fig. 1-15.

<sup>2</sup> Ibid., p. 77, pl. ix, fig. 2.



STENASTER.—*Billings.*

*Stenaster Salteri*, Billings. Geol. Surv. Canada, Organic Remains, pl. x, fig. 1 *a*, *b*, p. 78.

*Description.*—This species has rather short broad rays, which are narrower where they are attached to the very contracted body, than they are at about the centre of their length. In consequence of this form, the sides of the rays are not parallel, but a little curved outwards. As, however, only two specimens have been collected, and both appear to be a little flattened by vertical pressure, it may be that this leaf-like shape of the rays is accidental, and that in perfect specimens they taper uniformly from the body outwards. The adambulacral plates are oblong, and the sutures between them are nearly at right angles to the ambulacral grooves; those next the body are a little sloping outwards. Their length is about twice their breadth, and they are so disposed that the greater dimension is transverse, or at right angles to the groove; the extremities which lie next to the grooves are angular, and some of them appear to have the contiguous pores partly excavated in them. The oral plates are acutely triangular, the sharpest angle being towards the mouth. The plates are smooth. The ambulacral pores are very large, and the ossicles are much contracted in the middle, and greatly expanded along the median line of the bottom of the groove.

The most perfect specimen is one inch in diameter, measured between the tips of the rays; diameter of disc, three lines; width of ray at mid-length, two lines and a half. Dedicated to J. W. Salter, Esq., Palæontologist of the Geological Survey of the United Kingdom.

*Locality and Formation.*—Belleville, Canada West; Trenton Limestone. Collected by Dr. Billings.

*Stenaster pulchellus*, Billings. Geol. Surv. of Canada, Organic Remains, decade iii, pl. x, fig. 3, p. 79.

*Description.*—Rays long, slender and sub-cylindrical; adambulacral plates, transversely oblong; grooves narrow; dorsal plates small and tubular. Diameter of the only specimen in the collection two inches and one fourth, measured between the tips of the rays; arms one inch in length, and two lines and a half in width at the base; disc three lines and a half in diameter.

*Locality and Formation.*—Ottawa; Trenton Limestone. Collected by Dr. Billings.

PETRASTER.—*Billings*.

*Petraster rigidus*, Billings. Geol. Surv. of Canada, Organic Remains, decade iii, pl. x, fig. 3, p. 80.

*Description*.—This species has much the aspect of an *Astropecten*; the disc is one fourth the whole diameter, the rays rather slender, and uniformly tapering; the angles between the bases of the rays rounded. The plates, which appear to be adambulacral, are quadrate and a little convex; the marginal plates oblong, and also convex; the disc-plates consist of three at each angle, and a single row on each side of the ray, but extending only one third or one half of the length of the ray; they all lie between the marginal and adambulacral plates. The specimen figured was about two inches in diameter when perfect; width of disc, half an inch; and of rays at the base, about three lines.

*Locality and Formation*.—Trenton Limestone, Ottawa. Collected by Mr. J. Richardson.

PALÆOCOMA,<sup>1</sup> *Salter*.

The genus *Palæocoma* was proposed by Mr. Salter<sup>2</sup> to receive an interesting group of star-fishes, lately discovered at Leintwardine, Shropshire, in the thin flagstones of the Lower Ludlow Rock, which were there associated with *Pterygotus*, *Ceratiocaris* of several species, and *Limuloides*, a genus apparently allied to *Limulus*, together with new *Crinoidea* and *Polyzoa*, and many of the more common *Brachiopoda* and *Graptolites* of the Lower Ludlow series, which are here overlain by layers of Aymestry Limestone, full of *Pentamerus Knightii*.

*Palæocoma* is characterised by the elongated form of the narrow ambulacral ossicles, which are bordered by a double row of marginal adambulacral plates, the outer row supporting combs of long spines; "the spines are often so long as to form a complete fringe, and in one species the disc is equally spiniferous. In the curious sub-genus, *Bdellacoma*, they are short, and intermixed with some larger clavate spines on the upper surfaces; and in *Rhopalocoma*, which may hereafter have to be separated as a distinct genus, the hair-like spines are all absent, and clavate ones take their place."<sup>3</sup> *Palæocoma* is nearly related to *Pteraster militaris*, now living in the seas of Greenland and Spitzbergen, in the spinigerous character of the adambulacral plates, but differing from it in the manner

<sup>1</sup> The name *Palæocoma* was, unfortunately, previously given by the late M. A. d'Orbigny to a genus of the *Ophiuridæ*.

<sup>2</sup> 'Annals and Magazine of Natural History,' 2d series, vol. xx, p. 327, pl. ix, fig. 3.

<sup>3</sup> *Ibid.*, p. 327.

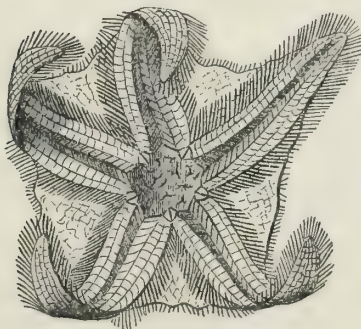


the spines are arranged thereon; *Pteraster* having combs of spines united by a membrane on the inner row of plates, and long, stiff, fin-like spines on the outer row, whilst *Palæocomma* has the outer row spinigerous, and the inner row destitute of these appendages. The three species of *Palæocomma* described by Mr. Salter, and the two sub-genera, *Bdellacoma* and *Rhopalocoma*, were all obtained from the Lower Ludlow Rocks at Leintwardine.

*Palæocomma Marstoni*, Salter. Ann. and Mag. Nat. Hist., vol. xx, p. 328, pl. ix, fig. 3.

Arms lanceolate, obtuse at the apex, united throughout by a delicate reticulate membrane clothed with spines; mouth opening wide, angle ossicles double; ambulacral grooves narrow, and bounded by two rows of small, quadrate ossicles; the margins of the rays are formed by two series of adambulacral plates, armed with regular oblique combs of long rigid spines, which form a conspicuous spinous fringe on the margins of the arms. Mr. Salter says, "that shorter spines, set at a wide angle from the margins of the arms, distinguish this from the next species. The beautiful and delicate web-like disc between the arms bears short spines also; it is sometimes expanded, as in fig. 17, but more generally contracted, so as only to make the arms a little broader, and give it a blunt appearance. The mouth is wide, of a true pentagonal shape, and with rather strong bordering plates, of which the triangular adambulacral plates are most conspicuous. The calcareous stellate spiculæ which dot over the thin disc are easily seen through the opening of the mouth."

FIG. 17.



*Palæocomma Marstoni*, Salter.

*Locality*.—Church Hill, Leintwardine, Shropshire, in Lower Ludlow Rock.

*Palæocomma Colvini*, Salt. Resembles the preceding species, but is remarkable for the length of its hair-like spines, which exceed those in any known star-fish, recent or fossil; it is found with the preceding.

*Palæocomma Cygnipes*, Salt. Arms elongate, marginal spines short, inter-brachial membrane delicately expanded, mouth opening small; found associated with the preceding.

Mr. Salter forms sub-genera of two other species belonging to this group, which present characters differing from other *Palæocommæ*.

*Sub-genus*—BDELLACOMA, *Salter*.

*Bdellacoma vermiformis*, Salt. Arms long, bordered by short spines; ambulacral avenues wide and flat, with large alternating apertures for the suckers. It is doubtful if the avenues are bordered by more than a single row of plates; but as there is a double set of tufts of spines, this is probable. The author observes, "the main character of the species, however, and that which distinguishes the sub-genus, is the possession of scattered clavate tubercles over the upper surface. These are nearly as long as the spines. The ambulacral avenues too, appear to differ materially from those of *Palæocomma*, in which they are remarkably narrow, and the plates close, while in *Bdellacoma* they are broad, and the ossicles remote."

*Locality*.—Leintwardine, in Lower Ludlow Rock.

*Sub-genus*—RHOPALOCOMA, *Salter*.

*Rhopalocoma pyrotechnica*, Salt. The sub-generic and specific characters of this fine species, the author states, must be taken together, and reside in the distribution of short, broad, clavate, and compressed spines over the upper surface and margin, rather more than their own breadth apart, and set on at the intersection of the reticular meshes, which cover the arms, and the angles between the arms, but which are quite absent from the central portion of the disc. This central portion above, which corresponds to the wide aperture of the mouth on the under surface, is covered only by scattered, stellate, calcareous spiculæ of large size. A closer reticulation is found on the portions between the arms, and the meshes become square in a double row, down the middle of the rays, and appear to correspond nearly in position to the ambulacral bones of the under surface. The latter are very slender and remote, even more so than in *B. vermiformis*, and form a broad ambulacrum, with only a few reticular plates bordering it, which bear clavate spines at intervals. The mouth angles project a good deal inwards, and are armed with short combs of spines."

*Locality*.—Leintwardine, in Lower Ludlow Rock.

PROTASTER, *Forbes*.

The genus *Protaster* was instituted by Professor Forbes, to comprehend those Silurian star-fishes which have a small circular disc covered with squamiform plates. The arms are



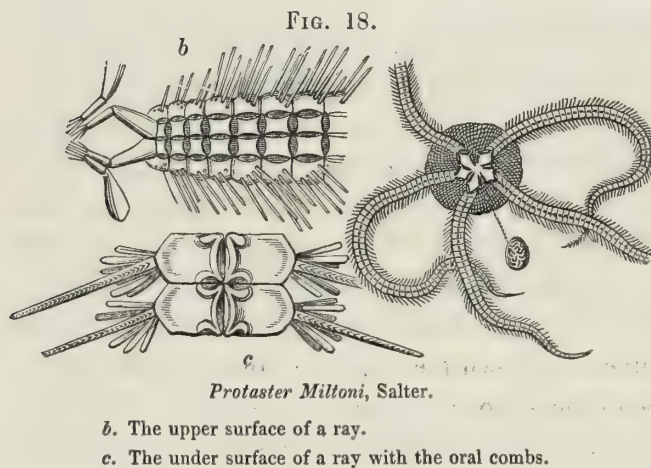
long, slender, and simple, and form a pentagonal rosette in the centre of the disc; they are constructed of two rows of alternating quadrate ossicles, which have their outer margin indented superiorly, to form spinigerous crests. The spines are apparently short, and not equal in length to that of an ossicle, obtuse, and few in a row. The madreporiform plate (fig. 18, *a*) has been found between two of the rays. This remarkable genus reminds us, at first sight, of the *Ophiuridæ*, to which it was referred by its author. The discovery of the madreporiform plate, however, removes it to its place among the *Asteriadae*. The alternating quadrate ossicula of the arms connect it by osteological affinities with the *Euryalidæ*, of which it appears to have been the ancient type.

*Protaster Miltoni*, Salter. Ann. and Mag. of Nat. Hist., 2d. series, vol. xx, p. 330, pl. ix, fig. 4.

“Disc round, one inch in diameter, and covered with small ridged plates; the arms are wide, composed of large ossicles, which become smaller at their base of insertion

in the disc above, having a wedge-shaped space between, which, joined with those of the other arms, forms a conspicuous pentagon above, equal in size to that formed by the divergent ossicles of the mouth below.

The arms themselves are made up of a double row of about forty pairs of squarish concave plates above, placed exactly opposite, not alternating as in other species (fig. 18 *b*). The sutures between these are deep, and the inner angles marked with a



deep pit or pore, bounded by tubercles, set cross-fashion. The outer margin bears a tuft of spines, long and short. On the under surface (fig. 18, *c*) the marginal plates are highly convex, and between them lies a double row of central plates of an hour-glass shape, on the outer sides of which, and between them and the marginal row, is a large, round aperture on either side—the passage for the tubular feet. The marginal plates bear a row of spines as long as the width of the arm, and striated across (fig. 18, *c*).

The oral pentagon is made up of twenty bones, five pairs of which are the central row enlarged (fig. 18, *b*), and these diverge at a wide angle, and nearly join the neighbouring pairs; the other five belong to the lateral rows, and are linear, set parallel, and bear the conspicuous, triturating combs of spines. The oral ossicles in this species form an angular

pentagon, being made up of straight pieces; in some others they are arched, and give an ogive form.

*Locality*.—Leintwardine, abundant of all sizes in Lower Ludlow Rock.

*Protaster leptosoma*, Salter. ‘Ann. and Mag. of Nat. Hist.,’ 2d series, vol. xx, p. 331, pl. ix, fig. 5.

Disc thin, membranous, seldom preserved; arms slender, one inch long; oral pentagon conspicuous, of a beautiful petaloid shape, constructed, according to Mr. Salter, of a series of ogives, the salient angles of which are inserted into the base of the arms and formed of three pairs of bones, while in *P. Miltoni* only two are distinct, and these are set in an angular form (fig. 17, c). Small spines are fixed to their extremities.

*Locality*.—Leintwardine in Lower Ludlow Rock.

*Protaster Sedgwickii*, Forbes. ‘Mem. Geol. Surv.,’ dec. i, pl. iv.

“The upper and under surfaces of the disc were covered by small, similar, more or less regular, polygonal or crescentic plates, imbricated in scale-fashion, and having punctated surfaces. Those of the under side of the body are smaller and more regular than those of the upper. The mouth is central, and rather small in proportion to the disc. The buccal apparatus is composed of ten parts or processes, arranged in pairs; half of each springs from the origin of each arm in a diverging manner, and meets the corresponding half to form a lanceolate, tooth-like projection, deeply indenting the cavity of the mouth. The arms were composed of alternating somewhat quadrate ossicula, the sides of which were deeply indentated superiorly, in order to form spiniferous crests. The spines were short, not equalling the length of an ossicle, obtuse, and few in a row; ambulacral grooves wide and convex; the central pentagon very deeply cut, of five oval, pointed petals.

*Locality*.—Underbarrow, Westmoreland, in Lower Ludlow Rock.

*Protaster Salteri*, Sow. ‘Quart. Jour. Geol. Soc.,’ vol. i, p. 20. 1845.

Discovered by Professor Sedgwick and Mr. Salter many years ago in Lower Silurian rocks, near Cerrig-y-Druidion on the Holyhead road; the original specimen has unfortunately been lost.



TÆNIASTER.—*Billings*.

This genus, according to Dr. Billings, differs from *Protaster* in the following particulars. *Protaster* has a well-developed disc, also pores outside of the ambulacral ossicles, and the oral plates are formed of two of the ambulacral ossicles; whilst *Tæniaster* has no disc nor marginal plates, and the oral plates are formed of two of the adambulacral plates.

These important distinctions justify the separation of the species into a separate genus, which presents many affinities with the *Ophiuridæ*.

*Tæniaster spinosus*, Billings. 'Canadian Organic Remains,' dec. iii, pl. x, fig. 3, p. 81.

*Description*.—The specimens collected are about seven lines in diameter; the rays linear-lanceolate, one line in width at the base, and covered at the sides with numerous small spines.

In the view of the enlarged specimen (pl. x. 36), the ambulacral ossicles appear in some places to alternate with each other, but this is owing to a distortion. Those on one side of the furrow are opposite those upon the other. The adambulacral plates are elongated, and so placed that the outer extremity of the one lies upon the inner extremity of the next. The rays are flexible.

*Locality and Formation*.—Falls of Montmorency, Trenton Limestone, collected by Dr. Billings.

*Tæniaster cylindricus*, Billings. 'Canadian Organic Remains,' dec. iii. pl. x. fig. 4., p. 81.

*Description*.—About an inch and a half in diameter, or a little more; rays sub-cylindrical, regularly rounded on the upper side, flattened on the lower, covered above with spines; about a line in width at the base, and tapering to an acute point.

This species is larger and more robust than the former. Both appear to be somewhat common, and the specimens are often found with their rays variously curved, showing that they were extremely flexible.

*Locality and Formation*.—City of Ottawa, Trenton Limestone. Collected by Dr. Billings.

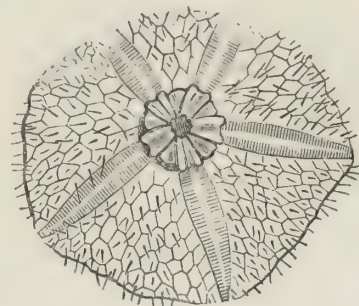
PALÆODISCUS.—*Salter*.

This genus has been proposed by Mr. Salter for a unique Asteroid, found at Leintwardine. The disc, which is incomplete, is formed of large, irregular, rhomboidal plates, which radiate in seven or eight rows from the mouth in each inter-ambulacral space, and are furnished with short spines. The only specimen at present known is

*Palæodiscus ferox*, Salt. 'Ann. and Mag. Nat. Hist.,' 2d series, vol. xx, p. 333, Pl. IX, fig. 6.

"The inner angles of the inter-ambulacra (fig. 18) form a prominent triangular boss, cut off distinctly by a furrow, and between these are the large elongated basal plates of the ambulacra, lying parallel, and not at all divergent; they are thick and blunt, and together with the five bosses form a circumscribed star in the centre, the massive character of which contrasts strikingly with the thinness and delicacy of all the other parts either of the ambulacra or disc. The ambulacra are small, composed of a double row of transverse plates, narrow, and more crowded than in *Palasterina* or *Palæaster*, and apparently very thin in texture. They can be detached and leave the upper plated surface free, which is covered with irregular plates. If there be no deception in this—for we have only a single specimen—the affinity would be much closer with the forms above mentioned, although the strong oral apparatus reminds us more nearly of *Protaster*.

FIG. 18.

*Palæodiscus ferox*, Salt.

*Locality*.—Leintwardine, in Lower Ludlow Rock; the only specimen is in the cabinet of Mr. Marston, of Ludlow.

Professor Forbes<sup>1</sup> described under the name *Lepidaster Grayi* a remarkable Echinoderm from the Wenlock limestone of Castle Hill, Dudley, which at first glance bears a resemblance to *Solaster*, a closer examination of its structure, however, shows that it possesses characters which justify its separation into a distinct genus, so widely different from other *Asteriadae*, that it may possibly form a connecting link between that order and the *Crinoidea*.

"The disc of *Lepidaster*," says Professor Forbes, "is very little more than two inches in diameter. It is, unfortunately, so much injured, that the elements cannot be clearly made

<sup>1</sup> 'Memoirs of the Geological Survey,' decade iii.



out, but appears to have had a framework composed of closely-set polygonal ossicula. Around it are arranged the rays, equidistant from each other, like so many spokes of a wheel. Their average length is one inch and one-twelfth, and their breadth towards the base, four-twelfths. They are regularly lanceolate. Their under surfaces are exposed on the slab, and are composed of thick, transversely oblong plates, slightly overlapping each other in scale-like fashion, and ranged in four longitudinal rows, two on each side of a central or ambulacral groove, which is itself towards the extremity, in some instances, partially filled up by small polygonal intervening plates. Of the two rows of border plates on each side of the groove, the inner series is formed of oblong obscurely hexagonal ones, with traces of punctations and grooves on the surfaces, as if for spines. The ray that is most perfect exhibits twenty-five plates in each row. The outer series consists of sub-orbicular or obscurely polygonal plates, which, like the inner ones, are gently convex on their surfaces. The upper surface of the ray, and probably of the body, was composed of numerous small, polygonal, nearly flat ossicula, closely set, and of various sizes."

This remarkable fossil was associated with several species of Crinoids, both perfect specimens and in fragments, but the most careful search has never brought to light another specimen of *Lepidaster*.

Besides the species above enumerated, other Palæozoic Asteroidea have been mentioned by the following authors.

Hisinger<sup>1</sup> described and figured *Palasterina antiqua* from Ludlow rocks at Mount Hoburg, Gothland, Sweden.

Professor James Hall<sup>2</sup> has figured and described *Palæaster matutina* from the Lower Silurian rocks of the State of New York.

Mr. Troost<sup>3</sup> has figured and described *Asterias antiqua* from Silurian rocks in the State of Tennessee, and the author alludes to five other undescribed species, from beds of the same formation.

Mr. Locke<sup>4</sup> has recorded the same species, *Asterias antiqua*, from the Lower Silurian rocks of the State of Pennsylvania.

Johannes Müller<sup>5</sup> has described as *Asterias Rhenana*, a star-fish with marginal plates, obtained from Devonian Sandstone at Coblenz.

M. Thorent<sup>6</sup> has figured and described a Palæozoic asteriad, under the name *Asterias constellata*, collected from Dumont's "Terrain anthraxifere," in France, in the department of l'Aisne; this star-fish belongs to the same group of forms which Forbes,

<sup>1</sup> Hisinger, 'Lethea Suecica,' t. lxxxix, t. 26, fig. 6.

<sup>2</sup> Hall, 'Palæontology of New York,' vol. i, t. 29, fig. 5.

<sup>3</sup> Troost, 'Transact. Geological Soc. Pennsylvania,' vol. i, p. 232, t. 10, fig. 9.

<sup>4</sup> Locke, 'Proc. Ac. N. S. Phil.,' vol. iii.

<sup>5</sup> Müller, 'Verh. Naturh. ver. für Rheinl. und Westphl. Jahrg.,' xii, 1855.

<sup>6</sup> Thorent, 'Mémoires Soc. Geol. de France,' tome iii, tab. 22, fig. 7.

in his memoir on the Palæozoic Asteriadae figured as *Uraster*, some of which are now grouped in the genus *Palæaster*.

M. Goldfuss<sup>1</sup> has figured as *Asterias obtusus*, a remarkable asteriad which was obtained by Alberti from the Muschelkalk of Friedrichshall in Württemberg.

It has been long known to palæontologists that a remarkable change is observed in the generic characters of many fossil animals found in the secondary formations when compared with those belonging to the same classes which are entombed in the Palæozoic series. Reptiles, fishes, mollusca, and articulata afford abundant evidence of such change, and the sub-kingdom radiata supplies additional proofs of the same organic law.

As the Oolitic Asteriadae will be figured and described in detail in this monograph, it is only necessary to state here that nearly all the species belong to the genera *Uraster*, *Astropecten*, *Luidia*, *Plumaster*, and *Goniaster*. The fossil species all appertain to extinct forms, but the genera to which they belong are nearly all living in our present seas.

The Cretaceous Asteriadae, which have already been beautifully figured in Dixon's 'Geology of Sussex,' will form the subject of a future monograph, to succeed the Cretaceous Echinidae now in course of publication. These interesting star-fishes of the Chalk period range themselves for the most part in the genera *Oreaster*, *Goniodiscus*, *Astrogonium*, *Stellaster*, and *Arthraster*.

The Tertiary formations have hitherto yielded very few species of ASTERIIDÆ. Those from the English tertiaries, representing *Astropecten* and *Goniaster*, have been figured by Professor Edward Forbes,<sup>2</sup> in his Radiaria of the London Clay; and the specimens from the Vienna basin, likewise belonging to the genera *Astropecten* and *Goniaster*, have been figured and described by Dr. Camil Heller in his paper "über neue fossile Stelliriden."<sup>3</sup>

## CLASSIFICATION OF THE ASTERIIDÆ.

The numerous forms presented by the animals of this division early induced Lillwyd and Petiver to give generic names, as *Asteriscus* and *Echinaster*, to certain of the group. The first systematic monograph which appeared was published by J. H. Linck<sup>4</sup> of Leipsic; this work was illustrated by forty-two well-executed plates, representing the leading forms known to him. This author divided the Star-fishes (*Asterias*, Linn.) into two sections, I. *STELLIS FISSIS*.—II. *STELLIS INTEGRIS*, characterised by the presence or absence of ambulacra on the underside of the rays. In the first section, which

<sup>1</sup> Goldfuss, 'Petrefacta Germaniæ,' Band i, p. 208, t. 63, fig. 3.

<sup>2</sup> Palæontographical Society Volume for 1852.

<sup>3</sup> 'Akademie der Wissenschaften,' Band xxviii des Jahrganges 1858, Wien.

<sup>4</sup> 'De Stellis Marinis liber singularis. Tabularum aenearum figuras,' Lepsic, 1733.



corresponds with our order Asteroidea, Linck proposed seven well established genera, as *Pentagonaster*, *Pentaceros*, *Astropecten*, *Palmipes*, *Stella coriacea*, *Sol marinus*, *Pentadactylosaster*, which have formed the basis of subsequent classifications. The "Class I. Stellarum pauciorum quam quinque radiorum," comprising *Trisactis* and *Tetractis*, included forms which were either varieties or malformations of other species; and "Class III. Stellæ marinas in plures quam quinque radios fissas," comprising *Hexactin*, *Heptactin*, *Octactis*, *Enneactin*, *Decactis*, *Dodecactis*, and *Triskaidecactis*, are in part included in the Sun-stars of modern authors.

De Blainville<sup>1</sup> divided the Asteriadæ into six sections; these nearly correspond with Linck's divisions, which were based on the form of body.

- A. Species with a pentagonal body, and few or no lobes at the circumference, the angles being fissured (LES OREILLERS, *Asterias discoidea*, Lamk.). Enc. Méthod. Pl. 97, fig. 3. *Asterias granularis*, Linn. Linck, Stellis Marinis, tab. xiii, fig. 3.
- B. Species pentagonal, body thin and membranous (LES PALMASTÈRIES = PALMIPES, Linck). *Palmipes membranaceus*, Retz. Forbes, Star-fishes p. 116. *P. rosaceus*, Lamk. Enc. Méth., Pl. 99, fig. 2.
- C. Species five-lobed, and not articulated at the circumference; ex. *Asterias minuta*, Linn. Enc. Méth., Pl. 100, fig. 1—3. *Pentaceros gibbus plicatus*, Linck, Stellis Marinis, t. 3, No. 20.
- D. Species pentagonal, more or less lobed and articulated at the circumference (LES SCATASTÈRIES; ou PLATASTÈRIES). Examples, *Pentagonaster semilunatus*, Linck, Stell. Mar. t. 23, fig. 37. *Goniaster equestris*, Gmelin, Forbes, Brit. Star-fishes, p. 125.
- E. Species deeply divided into five rays.
  - \* Rays triangular, depressed, and articulated at the borders (*Astropecten*, Linck; *Crenaster*, Luid.); examples, *Astropecten aurantiacus*, Linn. Forbes, Brit. Star-fishes, p. 130. Linck, Stell. Mar. t. 5 and 6.
  - \*\* Rays triangular, short, and rounded above; example, *Uraster rubens*, Linn. Forbes, Brit. Star-fishes, p. 83. *Uraster glacialis*, Linn.; Forbes, Brit. Star-fishes, p. 78.
  - \*\*\* Rays long, narrow, and often contracted at their origin. *Linckia variolata*, Agass. Linck, Stell. Mar. tab. i, fig. 1, tab. viii, fig. 10.
- F. Species which have more than five or six rays (LES SOLASTÈRIES). *Solaster papposa* Linn. Forbes, Brit. Star-fishes, p. 112, Stell. Mar., tab. xvii, No. 28, tab. xxxii, No. 52. *Luidia fragillissima*, Forbes, Brit. Star-fishes, p. 135.

<sup>1</sup> 'Dictionnaire des Sciences Naturelles,' art. "Zoophyte," p. 216, 1830.

Nardo<sup>1</sup> proposed to divide the European star-fishes into five genera, several of which correspond with the Linckian genera: 1st. STELLARIA = ASTROPECTEN, Linck (includes *A. aurantiaca*, *A. calcitrapa*). 2nd. STELLONIA = STELLA-CORIACEA, Linck (*A. rubens*, *A. glacialis*). 3rd. ASTERINA = PENTACEROS, Linck (*A. exigua*, *A. minuta*). 4th. ANSEPODA = PALMIPES, Linck (*A. membranacea*, *A. rosacea*). 5th. LINCKIA = PENTADACTYLOSASTER, Linck (*A. lævigata*, *A. variolosa*).

Professor Agassiz,<sup>2</sup> in his arrangement of the Echinodermata, proposed a division of the Asteriadae into nine genera, in which he substituted new names for Nardo's genera, and added others for extra European and extinct species. This arrangement is irrespective of the number of the rays.

1. ASTERIAS, Ag. (= *Astropecten*, Linck; *Crenaster*, Luid.; *Pentastérie*, Blainv.; *Stellaria*, Nardo.) The body stellate, the upper surface tessellate, and the rays depressed; the margin bordered with two rows of large plates, carrying small spines. Types of this genus, *A. aurantiaca*, *A. calcitrapa*.
2. CELASTER, Ag.—This genus differs from the preceding in having the inner cavity circumscribed by plates disposed as in the *Echinida*, and having in the anal area an ambulacral star. Type, *C. Couloni*, Ag.
3. GONIASTER, Ag. (= *Pentagonaster*, Linck; *Pentaceros*, Linck; *Scutastérie*, Blainv.) The body pentagonal, margin bordered by a double series of large plates which support spines and granules, upper surface nodulated. Types, *A. tessellata*, Lamk.; *A. equestris*, Linn.
4. OPHIDIASTER, Ag.—Rays long, cylindrical, or conical, covered with fine, close-set granules, ambulacral area very narrow. Type, *Asterias ophidiana*, Lamk.
5. LINCKIA, Nardo (= *Pentadactylosaster*, Linck). Body stellate; rays elongated, covered with tubercles, showing the porous integument in the intertubercular spaces. Type, *A. variolata*, Lamk.; Linck, Stel. Mar., tab. viii, fig. 10.
6. STELLONIA, Nardo (= *Stella coriacea*, Linck; *Pentastéries* in part and *Solastéries*, Blainv.) The body stellate and covered with spines more or less prominent. Types, *A. rubens*, Linn.; *A. glacialis*, Linn.; *A. endeca*, Linn., Linck, tab. xv, fig. 1; *A. papposa*, Linn., Linck, tab. xvii, No. 28; *A. helianthus*, Lamk.; Enc. Méth., Pl. 108.

<sup>1</sup> 'Naturforscher,' 1833. 'Isis,' 1834.

<sup>2</sup> 'Mémoires Soc. Sciences Naturelles de Neuchâtel,' tom. i, p. 190, 1836.



7. **ASTERINA**, Nardo (= *Asteriscus*, Luid.; *Pentaceros*, Linck). Body pentagonal, covered with pectinated scales, upper surface convex and inflated, under surface with deep, narrow, ambulacral areas. Type, *A. minuta*, Blainv., Linck, tab. iii, No. 20.
8. **PALMIPES**, Linck (= *Palmastérie*, Blainv.; *Anseropoda*, Nardo). Body pentagonal, much depressed, thin and membranous at the border. Type, *A. membranacea*, Retz., Linck, tab. i, fig. 2.
9. **CULCITA**, Ag. (= *Oreiller*, Blainv.) Body discoidal, pentagonal, fissured at the angles; the tegumentary membrane covered with granules. Type, *A. discoidea*, Lamk.; Encycl. Méthod., Pl. xcvi—xcix.

Dr. J. E. Gray published<sup>1</sup> a synopsis of the genera and species of Star-fishes in the collection of the British Museum and Zoological Society. The order ASTEROIDEA, or class HYPOSTOMA, of the author was thus subdivided:

SECT. 1.—*Ambulacra with four rows of feet; dorsal wart simple.*

Family 1.—ASTERIADÆ, including two genera.

1. **ASTERIAS**.—Skeleton netted with a single mobile spine at each anastomosis of the ossicula; body covered with more or less prominent, elongated, mobile spines. Type, *Asterias glacialis*, Linck, Stel. Mar. t. 38-39.
2. **TONIA**, Gr.—Skeleton netted with a series of crowded, small, blunt, mobile spines on the sides of each ossiculum; ambulacra bordered with a crowded series of subulate spines, and without any triangular pierced pieces within. *Tonia Atlantica*, Gr.

SECT. 2.—*Ambulacra with two rows of feet.*

Family 2.—ASTROPECTINIDÆ.

Back flattish, netted with numerous tubercles, crowned with radiating spines at the tip, called paxillæ.

1. **NAURICIA**, Gr.—Ambulacral spines broad and ciliated; two series of tesserae between the angles of the arms and the mouth beneath. Asiatic. *N. pulchella*, Gr., Seba. iii, t. 8, fig. 7.

<sup>1</sup> 'Annals and Magazine of Natural History,' vol. vi, pp. 175 and 275, 1841.

2. *ASTROPECTEN*, Linck.—Ambulacral spines simple, linear, without any tesserae between the marginal tubercles near the mouth and angles of the arms. *A. corniculatus*, Linck., Stel. Mar., t. 27 and 36.
3. *LUIDIA*, Forb.—Margin of the flat rays erect; dorsal surface crowded with regular paxillae. *L. fragillissima*, Forbes, Brit. Star-fishes, p. 135.
4. *PETALASTER*, Gr.—Margin of the rays shelving; dorsal surface with equal paxillae placed in longitudinal and transverse series. Asiatic, *P. Hardwickii*, Gr., Brit. Mus.
5. *SOLASTER*, Forb.—Rays many, with two series of broad spines bearing tubercles near the ambulacra. *S. papposa*, Forb., Brit. Star-fishes, p. 112.
6. *HENRICIA*, Gr.—Rays five, rounded, tapering, with rounded tubercles near the ambulacra; the dorsal wart obscure, concealed by spines. *H. oculata*, Penn.

*Family 3.—PENTACEROTIDÆ.*

The body supported by roundish or elongated pieces, covered with a smooth or granular skin, pierced with minute pores between the tubercles.

1. *CULCITA*, Ag.—Type, *Asterias Schmideliana*, Retz., Naturforscher., xvi, t. 1.
2. *PENTACEROS*, Linck.—Body convex above, margin with two rows of large spine-bearing tesserae. *P. gibbus*, Linck., Stel. Mar., t. 23, fig. 36.
3. *STELLASTER*, Gr.—Body depressed, covered with large, flat, regular six-sided plates; margin with two rows of large tesserae; the lower rows with a series of compressed mobile spines. *S. Childreni*, Gr., fig. 10.
4. *COMPTONIA*, Gr.—Body depressed, spinose? dorsal and oral disc covered with very small, flat plates; marginal ossicula large, without any mobile spines. *C. elegans*, Dixons, Fossils of Sussex, t. 22, fig. 9.
5. *GYMNASASTERIA*, Gr.—Type, *G. spinosa*, Gr., Brit. Mus.
6. *PAULIA*, Gr.—Body five-rayed, formed of flat, granulated, spine-bearing, irregular ossicula on the disc and margin, without any two-lipped pores. *P. horrida*, Gr., Brit. Mus.
7. *RANDASIA*, Gr.—Body pentagonal, with a tubercular skin above, and large granular plates beneath and on the margin, without any two-lipped slits, but with one or



two small pores near the oral angle beneath, where the tubercles are rubbed off. Allied to *Culcita*. *R. Luzonica*, Gr., Brit. Mus.

8. ANTHENEA, Gr.—Body five-rayed, chaffy, with immersed, elongated tubercle-bearing ossicula; margin with regular rows of large tesserae; both surfaces (especially the under) scattered with large two-lipped pores. *A. Chinensis*, Gr., Brit. Mus.
9. HOSIA, Gr.—Body five-rayed, formed of distinct, hexangular, nearly equal, slightly tubercular ossicula; back with small, and under surface with larger, two-lipped slits. *S. flavescens*, Gr.
10. HIPPIASTERIA, Gr.—Body four or five sided, formed of roundish ossicula, with a large, truncated, central tubercle; upper and under surfaces with two-lipped pores. *H. Europæa*, Gr., var. of *Goniaster equestris*, Gmel.
11. CALLIASTER, Gr.—Body five-rayed, with flat immersed ossicula, armed with flat-based, deciduous, conical spines, and without any two-lipped slits on either surface. *C. Childreni*, Gr.
12. GONIASTER, Ag.—Ossicula flat, the dorsal ossicula granulated and armed with deciduous, flat-based spines; both surfaces destitute of two-lipped pores. *Goniaster cuspidatus*, Linck., Stel. Mar., t. 21 and 23, fig. 37.
13. PENTAGONASTER, Linck.—Body formed of convex, smooth, and spineless ossicula; ossicles of the under side with a sunk, central line, a central perforation and a small pit at each end. Marginal ossicula near the tips of the rays very large and swollen. *P. pulchellus*, Gr.
14. TOSIA, Gr.—Body convex, formed of smooth, spineless ossicula; dorsal and ventral ossicula entire, subequal, without any impressed line; marginal ossicula two-rowed, with a small intermediate one near each tip; dorsal wart triangular. *T. Australis*, Gr.
15. ECHINASTER, Pet.—Body star-like, granulated, depressed; back rather convex, with a circle of ten to fifteen conical warts! Ambulacral spines small, placed in groups, with a single continuous row of large slender spines near them. Spines very long, covered with a granular skin, and having generally a second articulation about one third the length of the base. *E. Ellisii*, Solander and Ellis., Zooph., t. 60—62.
16. OTHILIA, Gr.—Skin smooth, polished; ambulacra with two very close series of filiform spines. *O. spinosa*, Linck., Stel. Mar., t. 4, fig. 17.

17. METRODIRA, Gr.—Slightly granular; rays slender, with large single pores and small scattered spines on the back; smooth, and formed of regular, flat ossicula on the sides. *M. subulata*, Gr.
18. RHOPIA, Gr.—*Stellonia*, Ag. Ambulacral spines long, with several series of larger spines near them. *R. seposita*, Retz.
19. FERDINA, Gr.—Body flat; rays broad, convex and warty above, flat and uniform beneath; ambulacral spines short, united at the base. *F. flavescens*, Leach.
20. DACTYLOSASTER, Gr.—Rays cylindrical, nearly smooth, formed of regular oblong ossicula, each furnished with a central group of unequal, short, mobile tubercles; one dorsal wart. *D. cylindricus*, Lamk.
21. TAMARIA, Gr.—Rays cylindrical, formed of seven series of granular, convex, roundish ossicula, each of the upper ones with three or four unequal, and the lower ones with a central, short, blunt spine. *T. fusca*, Gr.
22. CISTINA, Gr.—Rays cylindrical, nearly smooth, formed of rows of three-lobed flat ossicula, each furnished with a central, mobile spine; one or two oblong dorsal warts. *C. Columbiæ*, Gr.
23. OPHIDIASTER, Ag.—Rays cylindrical, elongate, uniformly granular all over, without any spines; back with a small central group of larger tubercles; dorsal wart concave, with radiating or twisting grooves. *O. aurantius*.
24. LINCKIA, Nardo.—*L. typus*, Nar.; *P. miliaris*, Linck., Stel. Mar., t. 28, fig. 47.
25. FROMIA, Gr.—Rays from five to eight, flat, triangular, formed of flat-topped, granular tubercles. *F. millepora*, Lam., Seba. Thesaur., t. 8, f. a. b.
26. GOMOPHIA, Gr.—Rays elongate, cylindrical, tapering, with a terminal tubercle; back with large rounded tubercles; back of the rays with a series of large, conical, convex, tubercular spines; the spines near the ambulacra small, crowded. *G. Egyptiaca*, Gr.
27. NARDOA, Gr.—Rays cylindrical, spineless, formed of large, granular, convex ossicula. *P. variolatus*, Linck., Stel. Mar., t. 8, fig. 10.
28. NARCISSIA, Gr.—Body pyramidal, thin, coriaceous, uniformly granular; rays tapering, elongate, triangular at the base, formed of thin, flattened ossicula. *N. Teneriffæ*, Gr.



29. *NECTRIA*, Gr.—Body rather pyramidal, coriaceous, scattered with truncated warts, granular at the top; rays roundish, produced, edged with two series of flat, granular warts on each side, beneath largely granular. *N. oculifera*, Lamk.
30. *NEPANTHIA*, Gr.—Body small, flat; rays very long, cylindrical, tapering, not margined, formed, above and below, of many regular longitudinal and transverse series of flat-topped tubercles, furnished at the top with a series of elongate, spine-like granulations. *N. tessellata*, Gr., Brit. Mus.
31. *MITHRODIA*, Gr.—Rays cylindrical, elongate, spinulose; skeleton netted with small, scattered, rugose spines, and a series of large, clavate, spinulose spines, regularly articulated to a broad, expanded base on the sides of the arms. *P. reticulatus*, Linck., Stel. Mar., t. 6, figs. 10 and 16.
32. *UNIOPHORA*, Gr.—Body rather depressed; rays broad, blunt; skeleton formed of a series of transverse, oblong ossicula, each bearing a large, unequal-sized, sub-globular, articulated spine, placed in a longitudinal series; dorsal wart convex, complicated. *U. globifera*, Gr.

*Family 4.*—*ASTERINIDÆ*.

Body discoidal or pyramidal, sharp-edged; skeleton formed of flattish, imbricate plates; dorsal wart single, rarely double.

1. *PALMIPES*, Linck.—Body flat, thin, nearly membranous, margin radiately striated; the dorsal ossicula with a radiating tuft, and the oral ones with a transverse line of many thin mobile spines; ambulacral spines in oblique, rounded groups. *P. membranaceus*, Linck., Stel. Mar., t. 1, fig. 2.
2. *PORANIA*, Gr.—Body pyramidal, thick, five-rayed; skin above and below varnished, spineless; dorsal ossicula irregular; margin with two series of large ossicula, the lower ones produced, sharp-edged, and each furnished on the edge with a series of mobile spines. *Goniaster Templetoni*, Forbes, Brit. Star-fishes, p. 122.
3. *ASTERINA*, Nardo.—Body rather pyramidal, five-rayed; the back convex; the oral surface flat; the ossicula of each surface furnished with one or more mobile, tapering spines; the margin sharp-edged, each of the ossicula with a marginal series of spines; ambulacral spines placed in groups of four or five. *Asterina gibbosa*, Penn., Forbes, Brit. Star-fishes, p. 119.

4. *PATIRIA*, Gr.—Body pyramidal, coriaceous, five-rayed: ossicula of the oral surface with uniform radiating groups of small spines; those of the dorsal surface of two kinds, the one crescent-shaped, with series of small bundles of spines, the others bearing irregular round bundles of spines between them. *P. coccinea*, Gr.
5. *SOCOMIA*, Gr.—Body depressed; rays elongate, formed of imbricate plates; the margins broad, the upper and lower series of ossicles separated by a groove. *S. paradoxa*, Gr.

Müller and Troschel proposed a new classification of fifty-five species of Asteriadae contained in the Berlin Museum,<sup>1</sup> this was afterwards amended by the introduction of other genera; these memoirs formed the Prodrôme of their 'System der Asteriden,'<sup>2</sup> which now constitutes a standard work upon the ASTERIIDÆ. As this important monograph is not much known in England, no apology is necessary for giving the following translation of the synopsis of the families and genera contained therein.

## SUMMARY OF THE FAMILIES AND GENERA OF THE ASTERIIDÆ.

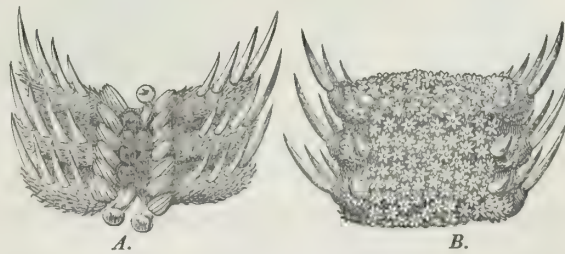
### FIRST FAMILY.

Four rows of tentacula in the ambulacral avenues. With a vent.

1 *Genus*.—ASTERACANTHION, M. and T. = *Stellonia*, Nardo; *Uraster*, Ag.

Rays long, many rows of spines near the ambulacral areas on the under side; the whole of the upper surface of the body and rays covered with blunt or pointed spines, either scattered singly or grouped together into tufts, and arranged more or less regularly in rows. The integument between the spines naked, showing the basis of the spines. In the naked skin many tentacule-pores. Pincers-like pedicellariæ, supported on soft stems, either encircling the basis of the spines or scattered between them, or both; some likewise on the borders of the avenues. Vent subcentral.

FIG. 20.



Portion of a ray of *Astropecten polyacanthus*, M. and T. *A*, under surface; *B*, the upper surface of the ray.

<sup>1</sup> 'Monatsbericht der Königl. Akad. der Wissenschaft,' Monat, April, 1840.

<sup>2</sup> 'System der Asteriden mit Zwölf Kupfertafeln, Braunschweig,' 1842.



## SECOND FAMILY.

Two rows of tentacula in the ambulacral avenues. With a vent.

2 Genus.—ECHINASTER, M. and T. = *Pentadactylosaster*, Linck.

Rays long, conical, or cylindrical; the skin supported on a network of calcareous pieces, from which longer or shorter spines proceed, sometimes alone or set close together. Skin between the spines naked, with many tentacule-pores. Vent subcentral.

3. Genus.—SOLASTER, Forbes.

FIG. 21.



Portion of a ray of *Solaster papposa*, Linn. A, the under; B, the upper surface.

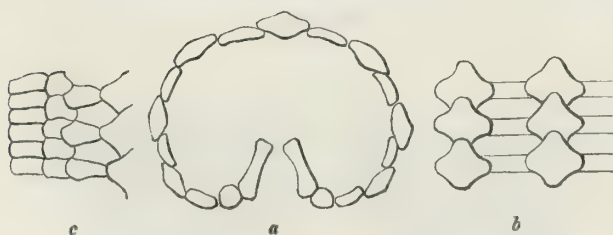
Body stellate, multiradiate; rays moderately long, and covered with fasciculated spines; skin between the spines naked, with many pores; no pedicellariæ; vent central.

4. Genus.—CHÆTASTER, M. and T.

Rays narrow and elongated, covered with plates which carry on their summits fasciculated spines, single pores between the plates; vent subcentral.

5. Genus.—OPHIDIASTER, Agass. = *Linckia*, Nardo (pars).

FIG. 22.



Section of a ray of *Ophidiaster*, with the inter-ambulacral plates.

Rays cylindrical or conical, everywhere covered with granular plates; many pores between the plates, which are likewise surrounded by granules; no pedicellariæ; vent central.

6. Genus.—SCYTASTER, M. and T. = *Pentadactylosaster*, Linck.; *Linckia*, Nardo.

Rays elongated; body stellate, everywhere covered with granular plates, which are arranged on the margins in two rows; the space between the plates likewise granulated. The pores between the plates single. No pedicellariæ; vent subcentral.

7. *Genus*.—*CULCITA*, Agass.

Body pentagonal, with a thick, blunt border, which forms a very high side-area, without plates at the margin. Body covered with granules, and fissured at the angles; valve-like and pincers-like pedicellariæ; vent subcentral.

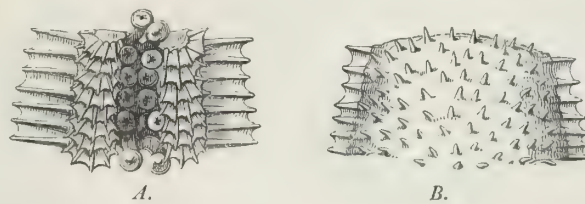
8. *Genus*.—*ASTERISCUS*, Luid. = *Asterina*, Nardo; *Palmipes*, Linck.

Body pentagonal, with short rays; under surface flat, upper surface more or less inflated or completely depressed, thin and membranous at the border, without plates. Ossicula on the under side covered with small, pointed, or blunt, or cylindrical spines, which stand either simply on each plate, or comb-like in rows. The plates on the upper surface covered with similar processes, either comb-like or fasciculated; single pores between the plates of the upper surface of the disc and of the rays. The pores cease, sooner or later, near the margin; vent subcentral.

9. *Genus*.—*PTERASTER*, M. and T.

In form it resembles the genus *Asteriscus*, with two rows of tentacula in the ambulacral avenues, and a central vent. The upper surface of the disc and rays is completely covered with a naked skin, from which tufts of small spines are regularly developed, and supported upon the osseous network of the ray. The border is armed with a series of longer spines, united together up to their extremities by a fold of the tegumentary membrane. The under side of the ray is provided with a series of transverse spines, formed into fan-like structures by folds of the skin, and superimposed on each other along the sides of the avenues; there are no pedicellariæ.

FIG. 23.

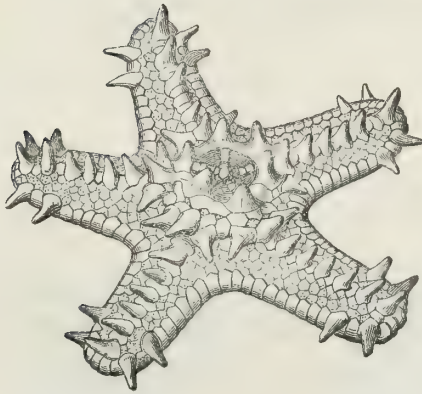


A portion of a ray of *Pteraster militaris*, M. and T.  
A, the under; B, the upper surface.



10. *Genus*.—OREASTER, M. and T. = *Pentaceros*, Linck.; *Goniaster*, Agass. (pars).

FIG. 24.

Upper surface of *Oreaster turritus*, Linck.

Under side flat, upper surface more or less elevated; the middle of the rays ridged with an angular, or strongly inflated, keel. Two rows of granular marginal plates; the border is formed by the upper row, and the lower row lies at the under surface. The body is everywhere covered with smaller or larger plates, which, with the marginal plates, are either entirely granular, or sometimes carry more or less spinous tubercles; the pore-fields between the plates of the upper surface are granulated with many pores. Pedicellariæ sessile, either valve-like or pincers-like; vent sub-central.

11. *Genus*.—ASTROGONIUM, M. and T. = *Pentagonaster*, Linck.; *Goniaster*, Agass.

Body pentagonal, disc-shaped, flat on both sides. Two rows of marginal plates, which are much larger than the other plates of the body. Both rows contribute to the formation of the margin. Their border is surrounded by a wreath of granules, or their circumference is encircled by granules. Up to this enclosure they are completely naked. Sometimes

FIG. 25.

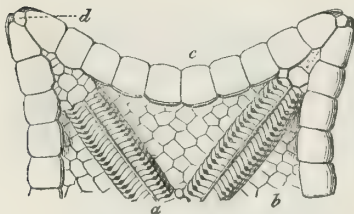
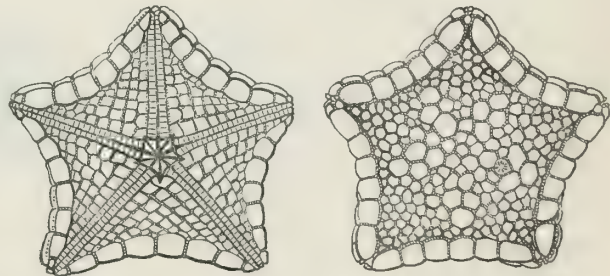
*Astrogonium cuspidatum*, M. and T.

FIG. 26.



A.

B.

*Astrogonium*, sp. Brit. Mus. Col.

they carry tubercles upon the middle. The upper and under surfaces are tessellated with free-lying plates; between these only narrow, granulated pores have places; vent sub-central.

12. *Genus*.—GONIODISCUS, M. and T.

Body pentagonal, disciform, flat on both sides. Two rows of large marginal plates at the border, the whole upper surface of which is granulated. The upper as well as the under marginal plates contribute their share to form the thick border, and divide the same into two equal parts; the pentagonal form of the disc is therefore maintained by this double row of marginal plates on the flanks and border. The upper and under surfaces are tessellated with a different form of granulation; vent subcentral.

13. *Genus*.—STELLASTER, Gray.

Body nearly pentagonal, flat on both sides, with two rows of large granulated marginal plates, both of which contribute to the formation of the high border. Each ventral marginal plate carries a suspended spine. Both surfaces of the disc are covered with granulated plates; vent subcentral.

FIG. 27.

Under surface of a ray of *Stellaster Childreni*, Gray.14. *Genus*.—ASTEROPSIS, M. and T.

Rays short in proportion to the pentagonal form of the body; under surface flat; upper surface more or less elevated; the rays sometimes ridged. Two rows of marginal plates; the border sharp, and formed only of one row of plates. The integument on the upper and under surface contains ossicula, but the interspaces of the plates, sometimes also the plates themselves, and always the pore-fields of the upper surface, are completely naked; vent subcentral.

15. *Genus*.—ARCHASTER, M. and T.

Body flat, with elongated rays. Two rows of large marginal plates; those of the lower series reach from the under part of the rays to the furrow-plates and are covered with scales, which at the border are metamorphosed into moveable spines; the upper series are covered with granules, which become bristle-like. The upper surface is level, and closely covered with appendages whose summits are crowned with small bristles. Between the paxillæ are single pores; vent central.



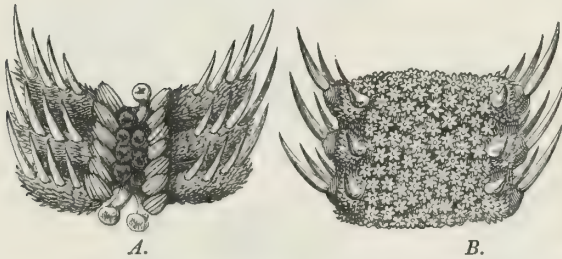
## THIRD FAMILY. ^

Two rows of ambulacral suckers in the avenues; without a vent.

16. *Genus*.—ASTROPECTEN, Linck.= *Stellaria*, Nardo; *Asterias*, Agass.

Body stellate, flat on both sides, with elongate rays. Two rows of large marginal

FIG. 28.



Portion of a ray of *Astropecten polyacanthus*, M. and T. *A*, under surface; *B*, the upper surface of the ray.

plates at the border. The lower series provided with spine-like scales, which increase from within outwards into long moveable spines. The dorsal marginal plates are covered with granules, which often become spinous, and sometimes carry spines. The flat upper surface of the body and rays thickly covered with appendages, the summits of which are

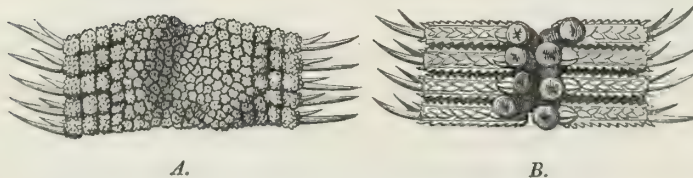
crowned with groups of minute spines, as in *Archaster*.

17. *Genus*.—CTENODISCUS, M. and T.

Body flat, almost pentagonal; at the border two rows of marginal plates, which are completely smooth on the upper surface. The marginal plates on the under surface form transverse bands, which are clothed with scales. A comb-like ridge of fine spines surrounds the border of these plates. The upper marginal plates have a row of large spines at the border, and the basal marginal plates support a row of similar spines near the avenues. The dorsal surface is covered with paxillæ, as in *Astropecten*.

18. *Genus*.—LUIDIA, Forbes.

FIG. 29.



Portion of a ray of *Luidia Senegalensis*. M. and T. *A*, the upper; *B*, the under surface.

Rays elongate. Instead of a double row of marginal plates, only a single row on the under side, with spines. The entire of the dorsal surface covered with paxillæ, as in *Astropecten* and *Ctenodiscus*.

DESCRIPTION  
OF THE  
FOSSIL OOLITIC ASTERIADÆ.

---

ON THE ASTERIADÆ OF THE LIAS.

BEFORE describing the Asteriadæ of the Lias I purpose giving a short account of the several zones of life into which this great formation is now divided, with the view of accurately defining the stratigraphical distribution of its Echinodermata in time and space. More ample details on the subject than my present limits permit will be found in the various works cited in the synonyms prefixed to the description of the different zones.

English geologists divide this formation into Upper Lias, Marlstone, and Lower Lias, but these subdivisions require additions and modifications in order to place the liassic beds of the British Isles in correct correlation with those of France, Switzerland, and Germany. For on the Upper Lias clays, in certain localities, are superimposed extensive arenaceous deposits, which, previous to the publication of my memoir on the Upper Lias sands,<sup>1</sup> were grouped with the Inferior Oolite, and in the Lower Lias are included several beds of clays and marls which, with the Marlstone of English authors, forms the Middle Lias of continental geologists.

Taking the Lias beds so well exposed in their natural order of superposition in the north and south of England in the magnificent sections on the Yorkshire and Dorsetshire coasts, and naming each group of beds by the most characteristic Ammonite contained therein, we find the following zones of life, taken in descending order :

THE UPPER LIAS.—The sands of the Upper Lias forming the upper portion of this zone, are characterised for the most part by Ammonites belonging to the group *Falciferi*, as *Ammonites opalinus*, Rein., and *A. radians*, Schloth. ; *Ammonites Jurensis*, Ziet., and *A. insignis*, Schübl., both belonging to other groups, are likewise associated with them.

<sup>1</sup> PALÆONTOGRAPHICAL AND STRATIGRAPHICAL RELATIONS of the so-called "SANDS of the INFERIOR OOLITE," 'Quart. Jour. of the Geological Society,' vol. xii, p. 292, 1856.



The clays of the Upper Lias forming the lower part of the zone, are everywhere distinguished by other species of *Falciferi*, as *Ammonites bifrons*, Brug.; *A. serpentinus*, Schloth., and numbers of the group *Planulati*, as *Ammonites communis*, Sow.; *A. anguinus*, Rein., and *A. fibulatus*, Sow.

THE MIDDLE LIAS.—This is divisible into five zones, each characterised in descending order by—*Ammonites spinatus*, Brug. 2. *A. margaritatus*, Mont. 3. *A. capricornus*, Schloth. 4. *A. Ibez*, Quenst. 5. *A. Jamesoni*, Sow.

THE LOWER LIAS is divisible into seven zones. These are—1. Zone of *A. raricostatus*, Ziet. 2. *A. oxynotus*, Quenst. 3. *A. obtusus*, Sow. 4. *A. Turneri*, Sow. 5. *A. Bucklandi*, Sow. 6. *A. angulatus*, Schloth. 7. *A. planorbis*, Sow.

Complicated as these subdivisions may at first sight appear to those who have regarded the Lias merely as a great clay deposit, with a uniform fauna throughout, still their accuracy may be clearly demonstrated in the grand section on the Dorsetshire coast, extending from near Bridport harbour on the east, to Pinhay bay on the west. Within these limits the entire series of beds rise beneath each other on the shore, and are exposed in the cliffs, so that this coast section may be said to be complete from the great arenaceous deposit of Upper Lias sand, containing *Ammonites opalinus*, with each succeeding zone of the Upper, Middle, and Lower Lias, down to *Ammonites planorbis*, and its *Ostrea* series resting on the *Avicula contorta* beds of the Trias formation.

In the following table I have placed the different zones of the English Lias in correlation with those of Germany, so well described by Professors Quenstedt, Oppel, Fraas, and others; those of France by the late M. A. d'Orbigny, and of those of England by Sir R. Murchison, Sir H. De la Beche, and the Rev. W. D. Conybeare.

A TABLE SHOWING THE CORRELATION OF THE LIAS BEDS OF FRANCE, GERMANY, AND ENGLAND.

SWABIA. <i>Quenstedt.</i>	WURTEMBERG. <i>Oppel.</i>	FRANCE. <i>D'Orbigny.</i>	SOUTH OF ENGLAND. <i>Wright.</i>	GLOSTERSHIRE. <i>Murchison.</i>	DORSETSHIRE. <i>De la Beche.</i>
Lias ζ. <i>Jurensismergel.</i>	Jurensis-bett.	<i>Toarcien.</i>	<i>Zone of</i> AMMONITES JURENSIS.	Inferior Oolite.	Inferior Oolite.
Lias ε. <i>Posidonien-schiefer.</i>	Posidonomyen-bett.	UPPER LIAS.	<i>Zone of</i> AMMONITES COMMUNIS.	Upper Lias.	Lower part.
Lias δ. <i>Amaltheenhone</i>	Spinatus-bett.	<i>Liasien.</i>  MIDDLE LIAS.	<i>Zone of</i> AMMONITES SPINATUS.	Marlstone.	Micaceous Marl.
Lias γ. <i>Numismal-mergel</i>	Margaritatus-bett.		<i>Zone of</i> AMMONITES MARGARITATUS.		
	Davæi-bett.		<i>Zone of</i> AMMONITES CAPRICORNUS.		
	Ibex-bett.		<i>Zone of</i> AMMONITES IBEX.		
	Jamesoni-bett.		<i>Zone of</i> AMMONITES JAMESONI.	Ochraceous Lias.	Belemnite Bed.  Upper Marl.
Lias β. <i>Turnerithone.</i>	Raricostatus-bett.		<i>Zone of</i> AMMONITES RARICOSTATUS.	Hippopodium & Lower Lias Cardinia Beds.	
	Oxynotus-bett.		<i>Zone of</i> AMMONITES OXYNOTUS.	Ammonite Bed.	Ammonites in nodules.
	Obtusus-bett.	<i>Sinemurien.</i>	<i>Zone of</i> AMMONITES OBTUSUS.		
	Tuberculatus-bett.	LOWER LIAS.	<i>Zone of</i> AMMONITES TURNERI.	Plagiostoma Beds.	Lias Limestones Lower Lias.
	Bucklandi-bett.		<i>Zone of</i> AMMONITES BUCKLANDI.		
	Angulatus-bett.		<i>Zone of</i> AMMONITES ANGULATUS.	Lower Lias Limestones	Limestones.
	Planorbis-bett.		<i>Zone of</i> AMMONITES PLANORBIS.	Saurian and In- sect Beds.	
				Black Shales and Bone Bed.	White Lias. White Lias, upper part.
Vorläufer des Lias.	Bone-bed.		<i>Zone of</i> AVICULA CONTORTA.		
					Lower Marl, Bone Bed.



The above table clearly shows how completely the whole Lias formation is represented in England, and how nearly it corresponds bed for bed with the Wurtemberg series. I shall now describe the different zones in ascending order, commencing with the lowest, the zone of *Ammonites planorbis*.

## THE LOWER LIAS.

### 1. THE ZONE OF AMMONITES PLANORBIS.

*Synonyms*.—"White Lias," William Smith, 'Memoir to the Map,' p. 47, 1815. "White Lias (pars)," De la Beche, 'Geol. Trans.,' 2nd series, vol. ii, p. 26. "Saurian Beds," Murchison's 'Geology of Cheltenham,' 2nd ed., by Buckman and Strickland, p. 49, 1845. "Psilonotenbank," Quenstedt, 'Der Jura,' Table, p. 293, 1857. "Die Schichten des Ammonites planorbis," Oppel, 'Juraformation,' p. 24, 1856. "Zone of Ammonites planorbis," Wright, 'Quart. Jour. Geol. Soc.,' vol. xvi, p. 389.

This division of the Lower Lias is well developed in the South of England.<sup>1</sup> In general it consists of a series of thin, grayish, or bluish, argillaceous limestones, with alternating beds of laminated shale; or sometimes it forms the upper part of the thick-bedded argillaceous, cream-coloured limestone, called "White Lias" by William Smith. In the upper half of this group of beds *Ammonites planorbis*, Sow., in some localities is found in considerable numbers, compressed in the shales, with its white shell more or less preserved; in the lower portion of the series *Ostrea liassica*, Strickl.,<sup>2</sup> appears in great numbers; beneath these strata are three or four beds of hard limestones (or "fire-stones"), in which the finest skeletons of *Enaliosauria* have been discovered. As this distinction, by means of *Am. planorbis*, *Ostrea liassica*, and Saurians, is a practical and useful one in the investigation of this zone of life, I shall adhere to it on the present occasion,—premising, however, that *Ammonites* are very rare in the lower beds, although abundant in the upper; and that *Ostreæ* are abundant below, but rare above, whilst Saurian remains are found throughout the entire series.

The best sections of the zone of *Ammonites planorbis* are those afforded by the extensive quarries at Street and the coast section at Watchet, in Somerset; at Binton

<sup>1</sup> The substance of the following observations on the Lower Lias is contained in my memoir on the "ZONE of AVICULA CONTORTA, and the LOWER LIAS of the SOUTH of ENGLAND," 'Quart. Jour. of the Geological Society,' vol. xvi, p. 374, 1860.

<sup>2</sup> *Ostrea liassica*, Strickland, is a very characteristic shell of the lowest Lias beds. It resembles *Ostrea irregularis*, Münster (Goldfuss, 'Petr. Germ.,' pl. vii—ix, fig. 5), and *Ostrea rugata*, Quenstedt ('Jura,' pl. iii, fig. 17). Dunker, in the 'Palæontographica,' (pl. vi, fig. 27), has figured a small Oyster from the Lias of Halberstadt (*Ostrea sublamellosa*, Dunker), which appears to be identical with our species. These small, thin, rugose Oysters are found in great abundance in the lowest beds of the Lower Lias in England and Germany. They are probably only varieties of one species, which had a wide geographical distribution in the seas which deposited the basement-beds of the Lias.

and Wilmcote, in Warwickshire; and at Pinhay Bay and Up Lyme, in Dorset. I purpose giving a detailed description of the most typical sections in each county.

*Somersetshire.*—At Street the strata are nearly horizontal and undisturbed, and therefore admit of accurate measurement. The following section of Mr. Cree's quarry I have compared with like sections afforded by the quarries of Messrs. Seymour, Underwood, and Talbot in the same parish; and find that the variation is so inconsiderable that any one may be said to represent the others, both as regards the sequence of the beds and the fossils they contain.

*Section of the Zone of Ammonites planorbis, at Street, Somerset.*

LITHOLOGY.		ORGANIC REMAINS; AND THE LOCAL NAMES OF BEDS.	
No.	ft. in.	PLANORBIS SERIES.	
1.	Light-coloured marly clay .....	3 0	"Top Bed." Saurian bones and <i>Ammonites planorbis</i> .
2.	Light-coloured Lias limestone .....	0 9	<i>Ammonites planorbis</i> in moulds.
3.	Yellowish laminated shale, splitting up into thin layers .....	3 0	<i>Ichthyosaurus intermedius</i> , <i>Ammonites planorbis</i> , <i>Lima punctata</i> , and <i>Isastræa Murchisoni</i> .
4.	Light-coloured shaly limestone .....	0 4	<i>Ammonites planorbis</i> , compressed.
5.	Hard gray limestone .....	0 7	"Building-stone." <i>Ammonites planorbis</i> , on the top of the bed, <i>Lima punctata</i> and <i>Lima gigantea</i> .
6.	Dark-gray shale .....	0 3	<i>Ammonites planorbis</i> , and muricated spines of <i>Cidaris</i> , <i>Edwardsi</i> .
7.	Dark-gray limestone .....	0 6	"Corn-sized building-stone." Spines of <i>Cidaris</i> and bones of <i>Ichthyosaurus tenuirostris</i> .
OSTREA SERIES.			
8.	Dark laminated shale .....	0 4	<i>Ostrea liassica</i> .
9.	Dark-gray limestone .....	0 5	"Five-inch building-stone." <i>Ostrea liassica</i> .
10.	Dark shale .....	0 3	<i>Ostrea liassica</i> .
11.	Dark-gray limestone .....	0 6	"Six-inch building-stone." <i>Cardinia crassiuscula</i> , <i>Lima punctata</i> , and <i>Ostrea liassica</i> .
12.	Dark shale .....	0 6	
13.	Grayish hard limestone, consisting of two 4-inch beds .....	0 8	"The Whetstones." Best paving-bed. Fossils rare: <i>Ostrea liassica</i> and <i>Modiola minima</i> .
14.	Hard dark marl .....	0 9	"Saurian bed." Many Saurians have been obtained here. <i>Ichthyosaurus intermedius</i> and <i>Plesiosaurus Hawkinsii</i> (British Museum). Jaws of Saurians and Fishes.
15.	Grayish fine-grained limestone .....	0 3	"The Cream-bed." Fine-grained paving-stone. <i>Ostrea</i> and <i>Modiola</i> .
16.	Brownish limestone.....	0 4	"Red Liver." Paving-stone. Few fossils.
17.	Dark-coloured limestone .....	0 4	The "Black stone," used for large paving-slabs; some of them 10 ft. by 5 ft. <i>Modiola minima</i> , <i>Ostrea liassica</i> , <i>Myacites</i> , and <i>Rhynchonella variabilis</i> .



LITHOLOGY.		ORGANIC REMAINS; AND THE LOCAL NAMES OF BEDS.	
No.		ft.	in.
18.	Dark-blue shale .....	0	2
19.	Hard grayish limestone .....	0	6
20.	Soft bluish shale .....	0	2
21.	Grayish-blue limestone .....	0	4
22.	Dark-gray laminated shale .....	0	4
23.	Hard blue limestone.....	1	0
24.	Gray laminated shale .....	1	3
25.	Grayish limestone .....	1	0
26.	Dark shale .....	0	2
27.	Thin-bedded limestone .....	0	3
28.	Thick blue limestone .....	0	5
29.	Hard fine-grained limestone .....	0	4
30.	Hard, gray, fine-grained limestone.....	0	4
31.	Hard gray limestone, forming the bottom bed .....	1	0

*Ostrea liassica* and *Modiola minima*.  
 "Six-inch building-stone." *Ceromya*, *Modiola minima*, and *Ostrea liassica*.  
 Fossils as in No. 19.  
*Ichthyosaurus intermedius* and *I. tenuirostris*.  
 "The Blue Clog," or "One-foot building-stone," used for steps. *Ceromya*, *Ostrea*, *Modiola*, and *Rhynchonella*.  
 Saurians abundant: *Ichthyosaurus intermedius* and *I. tenuirostris*, *Pholidophorus leptcephalus*, Agass.  
 "Gray Clog." A valuable building-stone, used for steps, troughs, &c. *Modiola minima*.  
 Fish-remains, *Modiola minima*, and *Otopteris acuminata*, L. & H.  
 "Fire-stone."  
*Plesiosaurus Etheridgii*. (In the Jermyn Street Museum; and another now in Street are from this bed.)  
 "Fire-stone, bottom bed." *Plesiosaurus Hawkinsii*. [The large *Ples. megacephalus*, Stutch., now in the Bristol Institution, was obtained from this bed near Street.]

The Saurian beds near Langport have likewise yielded Reptilian remains. I have obtained two fine specimens of *Ichthyosaurus intermedius* and an imperfect specimen of *I. tenuirostris* from this locality, which are now in the collections of private friends. In connexion with these Saurian beds of Somerset, it is important to note that the oldest *Enaliosauria* of the Lias are *Plesiosaurs*; *Plesiosaurus Hawkinsii*, Owen, and *Pl. Etheridgii*, Huxley, were both exhumed from the 4-inch firestone, forming the bottom bed of the *Ostrea* series; the remarkable *Plesiosaurus megacephalus*, Stutch., now in the Bristol Museum, was found likewise in the firestones of a quarry near Street Foss, and it will be shown in my section of the correlative beds of this zone at Wilmcote, in Warwickshire, that the fine skeleton of *Plesiosaurus megacephalus* contained in the Warwick Museum was likewise exhumed from the "firestones" of that locality—beds which are the precise equivalents of the "firestones" of Street.

The small number of *Conchifera* hitherto found in these beds is very remarkable. *Ostrea liassica*, Strickl., *O. irregularis*, Quenst., *Modiola minima*, Sow., *M. psilonoti*, Quenst., *Gervillia*, n. sp., *Anomya*, n. sp., *Myacites*, n. sp., *Arca*, n. sp., and *Cardium*, n. sp., are the only species I have as yet collected from the firestone-beds.

This section likewise settles a point which has been often discussed, namely, what is the age of the Saurian beds of Somerset? It has been generally supposed that they appertain to the same horizon as the lower Saurian beds at Lyme Regis; this, however, is a mistake, inasmuch as the Saurian beds at Street belong to the zone of *Ammonites planorbis*, whilst the Saurian remains at Lyme Regis, on the contrary, are for the most part found in and above the zone of *Ammonites Bucklandi*.

*Worcestershire and Gloucestershire.*—The *Am. planorbis*, *Ostrea*, and lower Saurian beds, so well developed at Street, are likewise found in different parts of Worcestershire and Gloucestershire, where they present the same stratigraphical relations, and yield the same organic remains.

The neighbourhood of Tewkesbury affords several good exposures of the infra-ammonite beds. I have obtained *Ichthyosaurus tenuirostris*, Conyb., and *Ichthyosaurus intermedius*, Conyb., from a bed of light-coloured Lias at Haselgrove, near “the Folly;” and the late Mr. Dudfield, of Tewkesbury, collected several very fine skeletons of *Ichthyosaurus tenuirostris*, Conyb., *I. intermedius*, Conyb., and *I. communis* (?), Conyb., with bones of *Plesiosaurus Hawkinsii*, at Bockeridge Common, and from similar beds at other localities around Tewkesbury; and I possess several vertebræ of *Plesiosaurus rugosus*, Owen, which were obtained from a bed of White Lias at Woolridge, near Hartpury.

The junction of the Lower Lias with the red marls of the Keuper in the Vale of Gloucester is, in general, indicated by a low escarpment, facing the west. At Bockeridge and Defford Commons this natural boundary is exceedingly well marked, and between these two localities are several quarries which expose to a greater or less extent the beds now under consideration. The presence of *Ammonites planorbis* in the upper strata of several of these sections has enabled me to correlate the beds beneath with the corresponding strata at Street, in Somerset, and at Binton, Grafton, and Wilmcote, in Warwickshire.



*Section of the Ammonites planorbis, Ostrea, and Lower Saurian beds at Brockeridge  
and Defford Commons.*

Zones.	STRATA AND ORGANIC REMAINS.	Brockeridge.	Strensham.
		ft. in.	ft. in.
<i>Ammonites planorbis</i> Beds.	1. Light-coloured clay .....	3 0	3 0
	2. White laminated limestone. "First rub," Brockeridge; "Chance rub," Strensham.....	0 4	0 4
	3. Brown laminated clay, with compressed white shells of <i>Ammonites</i> <i>planorbis</i> .....	3 0	2 0
	4. Blue argillaceous limestone.....	0 3	0 2
	5. Brown shaly clay.....	0 2	0 2
	6. Blue limestone.....	0 3	0 2
	7. Dark clay, with Saurian remains. "Yard clay".....	3 0	3 0
	8. Hard blue limestone. <i>Ostrea liassica</i> on the surface of the rock. This bed is called "Red nurf" at Brockeridge, "King's nurf" at Strensham .....	1 0	0 3
	9. Dark clay. The second bed of "Yard clay" at Strensham .....	1 6	3 0
<i>Ostrea and Lower Saurian</i> Beds.	10. Blue limestone. The "Queen's nurf," Strensham .....	0 3	0 3
	11. Blue clay .....	0 0	0 3
	12. Hard blue limestone, with <i>Modiola minima</i> .....	0 0	0 6
	13. Paving-stone, separated by an inch-band of clay .....	0 0	0 4
	14. Dark shale. Vertebrae of <i>Ichthyosaurus</i> , tests and spines of <i>Cidaris Edwardsi</i> , <i>Hemipedina</i> , sp., and Fishes' scales .....	0 0	0 6
	15. Hard blue limestone, in square blocks. "Brick-bed".....	0 0	0 5
	16. Dark shale .....	0 0	0 3
	17. Insect limestone; a hard argillaceous limestone, containing the Elytra and other remains of Insects .....	0 0	0 6
	18. Blue shale.....	0 0	1 3
	19. Light-blue limestone, with <i>Cardinia</i> , sp., <i>Arca</i> , sp., and <i>Astarte</i> , sp. ....	0 0	0 4

I have placed the above sections together for the purpose of comparison: they were first made by my friend, the Rev. P. B. Brodie, and have been subsequently examined by myself with similar results. These sections show the uniformity which prevails in the Lower Saurian beds of Gloucestershire and Worcestershire, and how much they resemble their correlative strata at Street.

The late Mr. James Dudfield, of Tewkesbury, obtained from the infra-ammonite Lias beds at Brockeridge enumerated in the preceding sections, and from other strata occupying the same horizon in the vicinity of that town, a very fine series of Saurian remains, which were all sold and dispersed in June, 1843. From my notes of that

collection I find there was a specimen of *Ichthyosaurus intermedius*, about 8 feet in length; the two fore-paddles and a portion of the scapular arch were tolerably complete; and there were upwards of 100 vertebræ and ribs nearly all in place. *I. tenuirostris*; 4 feet in length; the skulls, jaws, and teeth well preserved, the vertebral column tolerably complete; and likewise one fore-paddle. *I. communis*; very fine paddles. *I. platyodon*; large skull, with orbital plates in position. *Plesiosaurus Hawkinsii*; the vertebral column, ribs, and humeri; and fifty vertebræ in position.

The *Ostrea* and lower Saurian beds at Binton, Brockeridge, and Street are overlaid by clays and laminated shales, containing *Ammonites planorbis*. As these beds form a most important horizon in the Lias formation, and have a wide geographical distribution in England, France, and Germany, they require to be defined with accuracy, especially as some authors are of opinion that the true Lias commences with this zone of life.

The relation of the *Am. planorbis* shales to the Saurian beds below is extremely well exposed in the Railway-cutting at Uphill and in the quarries at Street, Binton, and Wilmcote, in Warwickshire, at Brockeridge Common, in Gloucestershire, and at Strensham, Worcestershire, and to the *Am. Bucklandi* or *Lima* beds above in the sections at Saltford, near Bristol; Penarth Head, near Cardiff; and Pinhay Bay, near Lyme Regis.

The following section of the beds at Binton was made by Mr. Robt. Tomes, of Welford Hill, near Stratford-on-Avon, from a quarry now abandoned. A similar exposition, however, is seen in the quarry worked near the former, the various beds of which I have examined and measured with Messrs. Tomes and Kershaw.

*Section of the Zones of Ammonites planorbis and Avicula contorta, at Binton,  
Warwickshire.*

No.	LITHOLOGY.	Thickness.		ORGANIC REMAINS; AND LOCAL NAMES OF THE BEDS.
		ft.	in.	
1.	Light-coloured limestone .....	0	6	"Top rock" or "Whites."
2.	Light-coloured clay .....	2	6	
3.	Argillaceous limestone .....	0	3	"Top Liveries." <i>Ichthyosaurus</i> ; on the upper surface; Insects.
4.	Light-coloured clay .....	7	0	
5.	Argillaceous limestone .....	0	3½	"Top Liveries" (lower). Insects; <i>Ammonites Johnstoni</i> , Sow.
6.	Clay .....	1	1	
7.	Grayish limestone .....	0	6	"Extra rock." "Thick paving-bed." No fossils.
8.	Clay .....	0	3½	
9.	Grayish limestone. Thin and irregular when covered by the preceding			"Quarters."
		2 in. to	0 3	
10.	Clay .....	0	8½	
11.	Grayish limestone. A constant bed .	0	3½	"Ribs." Insects.
12.	Clay .....	0	5½	



No.	LITHOLOGY.	Thickness. ft. in.	ORGANIC REMAINS; AND LOCAL NAMES OF THE BEDS.
13.	Limestone .....	0 3	"Paving-stone." A few Insects, and <i>Pholidophorus Stricklandi</i> , Ag.
14.	Clay .....	0 10½	
15.	Limestone .....	0 3¼	"Bottom rock." More Insects here than in all the other beds collectively.
16.	Clay .....	0 8	
17.	Limestone .....3 in. to	0 6	"Hoggs." <i>Tetragonolepis angulifer</i> , Ag. (Warwick Mus.)
18.	Strong hard clay .....	0 3½	
19.	Argillaceous limestone; imperfect stone .....	0 3	"Ruskin." No fossils in this quarry.
20.	Laminated clay .....	1 6	
21.	Fragmentary shelly limestone .....	0 1½	"Grizzle bed." Saurian bones, Fishes' teeth and scales, <i>Ammonites planorbis</i> , <i>Lima punctata</i> , <i>Cardium</i> , and <i>Ostrea liassica</i> ; spines of <i>Cidaris</i> and other <i>Echinidæ</i> abundant.
22.	Stoney shale.		
23.	Hard limestone .....	0 6	"Blue stone" or "Blocks." <i>Myacites</i> , and elytra of <i>Coleoptera</i> .
24.	Hard clay .....	1 3	
25.	Limestone .....	0 3½	"Grave-stone rock." <i>Ichthyosaurus</i> and <i>Otopteris acuminata</i> , L. & H.
26.	Clay. Thin hard plates of stone lie in this clay .....	0 11	
27.	Limestone, underlain by clay. (The clay frequently wanting) .....	0 0½	
28.	Limestone; inconstant.....	0 6	"Gummers." <i>Ostrea liassica</i> .
29.	Clay.		
30.	Hard gray limestone .....	0 6	"Fire-stone beds." Saurian remains and <i>Cardium</i> . <i>Modiola minima</i> , <i>Myacites</i> , and <i>Ostrea liassica</i> . In these limestones and clays only one small <i>Ammonites planorbis</i> has been found.
31.	Clay .....	0 2	
32.	Limestone .....	0 3	
33.	Clay .....	0 2	
34.	Limestone .....	0 3	
35.	Clay .....	0 3	"The Guinea-bed." Saurian bones, <i>Avicula longicostata</i> , Stutch., <i>Monotis decussata</i> (?), <i>Lima punctata</i> , <i>Myacites</i> , n. sp., <i>Ostrea liassica</i> , and <i>Hemipodina Tomesii</i> , Wright, in numbers; Coral.
36.	Hard dark limestone..... 1 in. to (This is the bottom bed of the quarry.)	0 10	
AVICULA CONTORTA BEDS.			
37.	Thick clay-bed; yellowish blue; breaking in angular fragments .....	8 0	[Belonging to the zone of <i>Avicula contorta</i> .]
38.	Dark ferruginous clay, with conchoidal fracture .....	8 0	Estheria bed. <i>Estheria minuta</i> .
39.	Clay .....	?	"Clear blue blocks."
40.	Laminated clays.....	3 0	

No.	LITHOLOGY.	Thickness.		ORGANIC REMAINS; AND LOCAL NAMES OF THE BEDS.
		ft.	in.	
41.	Light-coloured sandstone; micaceous	0	1	<i>Pullastra arenicola</i> , Strickl.
42.	Brown clay .....	0	2	
43.	Sandstone; micaceous .....	0	2	<i>Pullastra arenicola</i> , Strickl.
44.	Dark shaly clay.....	0	6	
45.	Soft sandstone .....	0	1	
46.	Black clay .....	0	3	
47.	Ferruginous vein, sandy .....	?		
48.	Gray Keuper marls.			

The beds from No. 37 to No. 48 were found *in situ* in an escarpment at a short distance from the quarry at Binton. It must be understood that the "Guinea-bed" is the lowest bed seen *in situ* in the pit, and that No. 37 occupies its natural position relatively to that bed, although it is not exposed in the Binton section.

*Lithology of the Ammonites planorbis beds.*—The *Am. planorbis* beds at Brockeridge (p. 58) consist of dark, laminated shales, with interstratified beds of marl and limestone. The shales split into very thin laminæ, between which innumerable shells of *Ammonites planorbis* lie closely compressed; the white, decomposed, pulverulent matter of the shell forming a strong contrast to the dark shales enclosing them. In Somersetshire the rock consists, at Uphill, of shales which greatly resemble those at Brockeridge; at Watchet, of dark clays which are more indurated and have preserved better the shell-structure: here *Ammonites planorbis* and *Am. Johnstoni* are found with the iridescent nacreous layer of their shells beautifully preserved. At Street the rock is a light-yellowish clay, with bands of grayish limestone and marl beneath, and in Worcestershire at Strensham, and in Warwickshire at Binton, similar lithological conditions prevail.

The White Lias series of the section at Saltford (see p. 64) represents in part the *Am. planorbis* beds: here also the relations of that zone to the Saurian beds below, and to the *Am. Bucklandi* beds above, are well shown. In Dorsetshire the *Am. planorbis* beds are represented by the upper portion of the White Lias so well exposed in the large quarries at Up-Lyme, and in the coast sections at Charlton and Pinhay Bays. The White Lias is raised at Up-Lyme for caustic lime; it consists of a fine-grained, cream-coloured limestone, apparently fit to be used as a lithographic stone. The two principal quarries afford the necessary details. Mr. Webb's quarry shows—

In the uppermost portion, thin bands of gray limestone interstratified with shales; in these are found *Ammonites planorbis* and *A. Johnstoni*; in two thick beds of dark, shaly clay are numerous spines and plates of sea-urchins, as *Cidaris Edwardsii*, Wright, *Pseudodiadema lobatum*, Wright, *Hemipodina Bechii*, Brod., *Hemipodina Bowerbankii*, Wright. These same shales are found at low water-mark at Pinhay Bay, and they have yielded nearly all the Echinidæ said to be found in the Lower Lias at Lyme Regis.

Beneath the lower bed of the *Cidaris* shales are several thin beds of light-coloured



limestone, locally called Whetstones, and separated by intermediate shales; then in descending order come the beds known as Grey Burr, Rotten Burr, Fire-stones, Cliff-ledge, Half-foot, One-foot, Red Size, and Anvil-ledge, all separated by thin bands of shale; on the surface of the limestones, and in the shales are many fossils, among which *Ostrea liassica* forms the dominant shell. The shale above Anvil-ledge contains great numbers of *Pullastra arenicola*, Strickland, apparently indicating a change of condition in the series of beds which lie below this fossil band. The beds from the Whetstones to the Pullastra shales represent the *Ostrea* series, and from the circumstance of the exposed edges of the rocks having weathered into a cream colour, they form the upper portion of the White Lias. The lower portion of this formation differs both lithologically and palæontologically from the upper portion; it is a compact, earthy limestone, with conchoidal fracture, cream-coloured, and close-grained; many of the beds are so fine that they might be used as lithographic stone. Beneath Anvil-ledge are three feet of light-coloured, rubbly beds, containing *Modiola psilonoti*, *Ostrea liassica*, *Myacites musculoides*? resting upon eighteen inches of White Lias; then follow a series of irregular beds, with thin partings, twelve feet in thickness, which overlie a bed, twenty-one inches thick, of fine, white limestone, resting on a like thickness of shale; beneath this is a bed of smooth, regular, fine, white limestone, six feet thick; then a bed of shale; and at the base of the series is a band of Cotham marble or Landscape stone. The lower portion of the White Lias from the Pullastra shales downwards represents, I believe, the upper part of the zone of *Avicula contorta*; there are many fossils in the limestones, which have not yet been determined. I have found casts of *Cardium Rhæticum*, *Monotis*, *Pullastra arenicola*, and shells of *Pecten Valoniensis*. Unfortunately the fossils are mostly in the form of moulds, and for this reason we must wait until good specimens are obtained. The lower portion of the White Lias series is only seen in Mr. Fowler's quarry at Up-Lyme.

The coast-section at Pinhay Bay is a complete repetition of the Up-Lyme quarries; the *Cidaris* shales are here well exposed at low water during spring tides, and from thence are obtained all the *Echinidæ* sold in Lyme Regis. I know of no *Asteriadæ* in these beds.

In Gloucestershire this zone is well exposed at Bockeridge Common, at Wainlode, in a quarry on the right-hand side of the Gloucester Road, between Hartpury and Ashelworth, and at Elmore, in quarries near the Old Kennel.

In Glamorganshire, it is seen in the fine coast-section at Penarth Head. In Somersetshire, in the cutting of the Great Western Railway at Saltford; in the Uphill Cutting on the Bristol and Exeter Railway; in the coast-section at Watchet; and in all the quarries at Street.

In Worcestershire it is found at Strensham; and in Warwickshire at Binton, Grafton, and Wilmcote.

It is likewise found at Robin Hood's Bay, on the coast of Yorkshire; the beds here lie below low-water mark, and large blocks, frequently washed up by the tide, are literally

crowded with *Ammonites planorbis*, known at Scarborough and Whitby as *Am. erugatus*, Bean.

The Coral-bed at Lussay, Isle of Skye,<sup>1</sup> probably represents the zone *Am. planorbis*, as I found the same species as the Hebridean coral in the light-coloured clays with *Am. planorbis* at Street.

This lowest Ammonite-zone has, therefore, a wide geographical distribution throughout the Lower Lias of the northern, midland, and southern counties of England, and it retains the same relative position in the Lower Lias of France, Germany, and Switzerland.

*Fossils of the Ammonites planorbis beds.*—The fauna of this zone is very limited; at present I know only the following species:

<i>Ichthyosaurus intermedius</i> , <i>Conyb.</i>	<i>Lima gigantea</i> , <i>Sow.</i>
— <i>tenuirostris</i> , <i>Conyb.</i>	— <i>pectinoides</i> , <i>Sow.</i>
— <i>communis</i> , <i>Conyb.</i>	<i>Cardinia crassiuscula</i> , <i>Sow.</i>
<i>Plesiosaurus Hawkinsii</i> , <i>Conyb.</i>	<i>Unicardium cardioides</i> , <i>Phil.</i>
— <i>Etheridgii</i> , <i>Huxl.</i>	<i>Ostrea liassica</i> , <i>Strick.</i>
— <i>rugosus</i> , <i>Ow.</i>	<i>Myacites musculoides</i> ? <i>Schloth.</i>
— <i>dolichodeirus</i> , <i>Conyb.</i>	<i>Rhynchonella variabilis</i> , <i>Schloth.</i>
— <i>megacephalus</i> , <i>Stutch.</i>	<i>Cidaris Edwardsii</i> , <i>Wr.</i>
<i>Dapedius</i> .	<i>Pseudodiadema lobatum</i> , <i>Wr.</i>
<i>Pholidophorus leptcephalus</i> , <i>Ag.</i>	<i>Hemipedina Bechei</i> , <i>Brod.</i>
— <i>Stricklandi</i> , <i>Ag.</i>	— <i>Bowerbankii</i> , <i>Wr.</i>
<i>Ammonites planorbis</i> , <i>Sow.</i>	— <i>Tomesii</i> , <i>Wr.</i>
— <i>Johnstoni</i> , <i>Sow.</i>	<i>Isastræa Murchisoni</i> , <i>Wr.</i>
<i>Lima punctata</i> , <i>Sow.</i>	

## 2. THE ZONE OF AMMONITES ANGULATUS.

*Synonyms.*—"Sandige Kalke und Sandsteine mit *Am. angulatus*, Quenst.," 'Flötzgeb.,' 541. "Grès infraliasique (pars)," Dufrénoy and De Beaumont. "Grès liasique, grès de Hettange," Terquem, 'Paléont. du Dép. de la Moselle,' p. 11. "Die Schichten des *Ammonites angulatus*," Oppel, 'Juraformation,' p. 28. "Zone à *Ammonites Moreanus*," Martin, "Pal. Stratigraph. de l'Infra-lias du Départ. de la Côte-d'Or," 'Mém. Géol. Soc. de France,' p. 38, 2nd série, 1860.

The zone of *Ammonites angulatus*, so far as it has been exposed, appears to be imperfectly developed in the British Isles, and from the difficulty experienced in separating its beds from the Bucklandi series, they were grouped with the latter in my memoir. On the Continent, however, and especially in France, this zone forms a very important horizon, and contains a rich fauna. M. Jules Martin,<sup>2</sup> in his valuable memoir on the Infra-Lias of the department of the Côte-d'Or, says, "this zone forms one of the best

<sup>1</sup> 'Quart. Journ. Geol. Soc.,' vol. xiv, pp. 4 and 34.

<sup>2</sup> 'Paléontologie Stratigraphique d'Infra-Lias du département de la Côte-d'Or,' p. 39, 1860. 'Mém. Soc. Géol. de France,' 2nd série, tom. vii, Mem. No. 1.



characterised palæontological horizons in the Côte-d'Or, and contains the richest and most varied fauna. Limited to two or three yards in thickness, this deposit appears to correspond to a period of animalisation of admirable fecundity. It is from these that we have collected the charming fauna which we last year indicated, and which has such intimate relations with the Hettangian fauna described by M. Terquem." From this zone M. Martin has collected and catalogued—1 *Ichthyosaurus*, 1 *Ichthyodorulite*, 10 sp. of *Cephalopoda*, 63 sp. of *Gasteropoda*, 77 sp. of *Conchifera*, 5 sp. of *Brachiopoda*, 4 sp. of *Echinodermata*, 10 sp. of *Anthozoa*, 3 sp. *Annelida*, and the débris of *Crustacea*. In the department of the Moselle M. Terquem<sup>1</sup> has catalogued 177 species from the same zone. *Ammonites angulatus*, Schloth., is found between Charmouth and Lyme Regis, in dark shale, below the gray concretionary limestone, with a mammillated surface, and likewise in the same strata south-west of the Cob. From these beds I have collected the different varieties of this Ammonite which have been figured by d'Orbigny under the names *Moreanus*, *catenatus*, and *Charmassei*, all of which I regard only as so many different forms of *Ammonites angulatus*, Schloth.

This zone was well exposed in the Harbury cutting of the Great Western Railway, near Warwick, although very few Mollusca besides *Ammonites angulatus* were obtained therefrom; on the spoil banks, even now, some good fragments are occasionally found. On the coast of Yorkshire it occurs near Redcar, where small specimens of this shell, under the local name *Ammonites Redcarensis*, are collected from the clay. In Gloucestershire I have seen small specimens, which were found near Aust and near Gloucester. This zone is likewise exposed in the north of Ireland, in the remarkable Lias district near Portrush.

### 3. THE ZONE OF AMMONITES BUCKLANDI, OR THE LIMA-BEDS.

*Synonyms*.—"Blue Lias," William Smith, 'Mém. to the Map,' 1815. "Blue Lias Limestone," De la Beche, 'Geol. Trans.,' vol. ii, 2nd series, 1829. "Gryphiten-Kalkstein," Alberti, 'Die Gebirge des König,' Württemberg, p. 121, 1826. "Liaskalk," Mandelsloh, 'Geol. Profile der schwäbisch,' Alpen, p. 28, 1834. "Calcaire à Gryphée arquée" (pars), Dufrénoy et de Beaumont, 'Mém. Soc. Géol. de France,' 1830. "Grès de Luxembourg (pars. sup.)," Omalius d'Halloy. "Grès de Luxembourg," Dewalque, Descrip. du Lias de la Luxembourg, p. 28, 1857. "Plagiostoma-beds, Lower Lias," Murchison, 'Geol. of Cheltenham,' 2nd ed., p. 49, 1845. "Arietenkalk," Quenstedt, 'Der Jura,' Table, p. 293, 1857. "Die Schichten des Ammonites Bucklandi," Oppel, 'Juraformation,' p. 35, 1856. "Zone of *Ammonites Bucklandi*," Wright, 'Quart. Jour. Geol. Soc.,' vol. xvi, p. 398.

The zone of *Ammonites Bucklandi* (or *Lima*-beds) forms an important subdivision of the Lower Lias. This series attains a great development in the midland counties and in

<sup>1</sup> 'Paléontologie du département de la Moselle,' p. 12, 1855.

Glamorganshire, Somerset, and Dorset. This zone of life is characterised throughout by the prevalence of a number of large *Ammonites* belonging to the natural group *Arietes* (von Buch), and by many *Conchifera* of the genera *Lima* and *Gryphæa*. In England it everywhere consists of beds of bluish argillaceous limestone, interstratified with beds of marl, shale, and clay of a similar colour. In some parts of Warwick, Somerset, Dorset, and Glamorgan, this series attains a thickness of 80 feet.

*Gloucestershire and Somersetshire.*—In Gloucestershire it was partly laid open by the deep cutting of the Dean Forest Railway at Highnam, and it is seen in the Lias limestone-quarries near Tewkesbury, and in the natural escarpments at Frethern and Purton-on-the-Severn. In Somersetshire it was fully exposed in making the Great Western Railway between Bristol and Bath, and probably at no point were the several beds of the *Lima* series better shown than in the cutting at Saltford, seven miles from Bristol. My friend, Mr. William Sanders, made the following section during the execution of the work which, together with his notes on the fossils contained in the different strata, has been kindly communicated by my friend, Mr. Etheridge. This section is of great value, inasmuch as the beds are now partially concealed by *débris* and vegetation, and the characteristic fossils can no longer be found in their respective beds.

*Section of the Lower Lias Beds at Saltford, seven miles from Bristol, on the Great Western Railway.<sup>1</sup>*

No.	LITHOLOGY.	Thickness. feet.	ORGANIC REMAINS.
	Brown gravelly marl .....	120	
	Beds of laminated shale and clay.....	110	
	Dark clay, with boulders, and layers of septaria at the top and bottom of the bed, and in the clay between .....	105	Scales of <i>Tetragonolepis</i> and <i>Belemnites acutus</i> , Mill.
59.	Gray Lias limestone .....	100	<i>Rhynchonella variabilis</i> , Schloth.
58.	Dark shale.....		<i>Belemnites acutus</i> , Mill.
	Gray Lias limestone.		
	Dark shale.....		<i>Ostrea læviuscula</i> , Sow., <i>Avicula</i> , and <i>Pecten</i> .
57.	Gray Lias limestone .....		<i>Ammonites Conybeari</i> , Sow., and <i>Belemn. acutus</i> , Mill.
	Dark shale.		
56.	Thin limestone-band.		
	Dark limestone .....		<i>Nautilus striatus</i> , Sow., <i>Am. Conybeari</i> , Sow., and <i>Belemnites acutus</i> , Mill.

<sup>1</sup> This section shows the relative position of the zones of *Ammonites Bucklandi* and *Am. planorbis* and the *Avicula contorta* series in this part of the county, and affords a good type for comparing these zones in Somersetshire with the same groups in other parts of the south of England.



No.	LITHOLOGY.	Thickness. feet.	ORGANIC REMAINS.
55.	Gray Lias limestone .....	95	<i>Lima gigantea</i> , Sow., and <i>Spirifera Walcottii</i> , Sow.
	Dark limestone.		
54.	Gray Lias limestone.		
	Dark shale.		
53.	Gray Lias limestone.		
	Dark laminated shale.		
52.	Dark-gray Lias limestone .....		Vertebrae of <i>Ichthyosaurus</i> , <i>Am. Bucklandi</i> , Sow., and <i>Spirifera Walcottii</i> , Sow.
	Dark shale .....		<i>Am. Bucklandi</i> , Sow., <i>Nautilus striatus</i> , Sow., and <i>Spirifera Walcottii</i> , Sow.
51.	Gray Lias limestone .....	90	
	Dark shale.		
50.	Gray Lias limestone .....		
	Dark shale .....		<i>Hybodus curtus</i> , Agass.
49.	Gray Lias limestone .....		<i>Pholadomya glabra</i> , Agass.
	Dark shales .....		<i>Nautilus striatus</i> , Sow. (large), <i>Am. Brookii</i> , Sow., and fossil wood.
48.	Gray Lias limestone .....		<i>Am. Conybeari</i> , Sow., and <i>Am. Bucklandi</i> , Sow.
	Dark shales .....		<i>Pleurotomaria similis</i> , Sow., and <i>Lima gigantea</i> , Sow.
			<i>Am. Bucklandi</i> , Sow., and <i>Pleurotomaria similis</i> , Sow.
47.	Gray Lias limestone.		
	Dark shales .....	85	<i>Ammonites Conybeari</i> , Sow.
46.	Gray Lias limestone .....		
	Dark shales .....		
			<i>Nautilus striatus</i> , Sow. (large).
			<i>Pentacrinus tuberculatus</i> , Mill., (stem) and <i>Pecten textorius</i> , Goldf.
45.	Dark-gray limestones.....		<i>Ichthyosaurus communis</i> , Conyb.
	Dark shales .....		<i>Gryphæa incurva</i> , Sow., and <i>Pentacrinus tuberculatus</i> , Mill.
44.	Gray limestone.		
	Dark shales.		
43.	Gray limestone .....		<i>Ichthyosaurus communis</i> , Conyb., and <i>Am. Conybeari</i> , Sow.
	Dark shales .....		<i>Pinna Hartmanni</i> , Ziet., and <i>Gryphæa incurva</i> , Sow.
42.	Bluish limestone .....	80	<i>Pholadomya glabra</i> , Ag., and <i>Lima</i> , n. sp., with large ribs, <i>Gryphæa incurva</i> , Sow., and <i>Rhynchonella variabilis</i> , Schl.
41.	Thirteen or fourteen lime-stone bands, with irregular surfaces; some nodular, with partings of clay and shale ...		
		75	<i>Pholadomya glabra</i> , Ag., and <i>Lima gigantea</i> , Sow.
40.	From sixteen to eighteen beds, comprising 20 inches of stone .....	70	<i>Pecten textorius</i> , Schl. <i>Pholadomya glabra</i> , Ag., and <i>Pleurotomaria similis</i> , Sow.
39.	Fourteen beds of limestone and clay.....		
38.	Eight beds of limestone and clay .....		<i>Lima pectinoides</i> , Sow., and <i>Cardinia ovalis</i> , Stutch.
37.	Thirteen beds of limestone and clay; the limestones irregular, water-worn, and nodular.....	65	<i>Pholadomya glabra</i> , Ag., <i>Rhynchonella variabilis</i> , Schl., and <i>Ostrea</i> .
	Dark laminated shales .....		
36.	Gray limestone.		<i>Ostrea</i> .

		LITHOLOGY.	Thickness. feet.	ORGANIC REMAINS.
White Lias Series, 32 feet in thickness.	No.	Dark shales.		
	35.	Grayish limestone .....	60	
	34.	Ten beds of shales and limestone ; septaria in the lower beds.		
	33.	Thin gray limestone.		
		Thick dark clay.		
	32.	Thin band of limestone.		
		Dark clay.		
	31.	Thin band of limestone .....	50	
		Thick dark shales.		
	30—25.	Six beds of limestone, alternating with six thicker beds of clay .....	43	
	24.	Light-cloured limestone.		
		Dark-coloured shale.		
	23.	Light-coloured limestone.		
		Dark shale.		
	22.	Thick White Lias .....	40	
<i>Avicula contorta</i> Series, 25 feet in thickness.	21—12.	Twelve beds of White Lias, separated by thin bands of clay .....	35	<i>Pinna Hartmanni</i> , Ziet., and <i>Unicardium cardioides</i> , Phil.
	11, 10.	Four beds of limestone, becoming thin and rubbly beneath, and nodular at the base .....	30	<i>Pecten textorius</i> , Goldf., and <i>Pholadomya glabra</i> , Ag., <i>Modiola Hillana</i> , Sow., and <i>Avicula</i> (small).
	9.	Cotham marble or Landscape-stone	25	
		Black shales.		
	8.	Band of limestone .....	20	
	7.	Nodular limestone.		
		Black shales .....	15	Fishes' scales ; layers of compressed <i>Pullastra arenicola</i> , Strickl.
	6.	Dark limestone .....	10	<i>Pecten Valoniensis</i> , Defr., and <i>Avicula contorta</i> , Portl.
		Dark shale.		
	5.	Dark limestone .....		<i>Pullastra arenicola</i> , Strickl.
		Dark shale.		
	4.	Greenish brown soft marl.		
		Marlstone.		
	3.	Pale-bluish clay, with plant-like fibres .....	5	
	2.	Buff-coloured clay.		
	1.	Gray sandy marlstone, with ferruginous spots.		
		New Red Marl.		



*Lyme Regis*.—The zone of *Ammonites Bucklandi* is admirably exposed in the coast-section at Lyme Regis, Dorset, both in the Church Cliffs and at Pinhay Bay, where the beds consist of a series of gray limestones, from 2 to 10 inches in thickness, varying from earthy to compact, and alternating with marls and shaly beds—either seams of a few inches, or beds of many feet in thickness. The following section, from the lowest stratum on the shore to Broad Ledge, which may be considered as the uppermost bed of the *Am. Bucklandi* or *Lima* series, affords a correct view of the stratigraphical order of these strata and of the fossils they contain.

*Section of the Ammonites Bucklandi or Lima beds from Broad Ledge to the shore at Lyme Regis.*

		LITHOLOGY.		ORGANIC REMAINS.	
		No.	ft. in.		
Am. Turneri Beds.	1.	Dark-gray limestone. "Broad Ledge" or "Table-bed" .....	3 6	<i>Rhynchonella variabilis</i> , Schloth, in masses.	
	2.	Dark marls and shales, with bands of clays .....	15 0	<i>Ichthyosaurus communis</i> , Conyb., <i>I. platyodon</i> , Conyb., <i>Ammonites semicostatus</i> , Y. & B., and <i>Rhynchonella variabilis</i> , Schl.	
	3.	Gray limestone .....	0 4	<i>Ammonites Turneri</i> , Sow., and <i>Am. semicostatus</i> , Y. & B.	
	4.	Dark slaty marls .....	4 0		
	5.	Dark-gray limestone .....	1 0	<i>Lima gigantea</i> , Sow., <i>L. antiquata</i> , Sow., and <i>Rhynchonella variabilis</i> , Schloth.	
	6.	Black shales, with partings of gypsum .....	2 6	<i>Ichthyosaurus communis</i> , Conyb. (in the "fire-stone beds" west of the Cobb).	
	7.	Dark-grayish limestone .....	0 10	<i>Lima gigantea</i> , Sow., <i>L. antiquata</i> , Sow., and <i>Rhynchonella variabilis</i> , Schloth.	
Am. Bucklandi or Lima Beds.	8.	Dark-shale .....	2 0	<i>Gryphæa incurva</i> , Sow.	
	9.	Hard gray limestone. "Gray Ledge" .....	1 3	Fin-spines of <i>Hybodus</i> , <i>Rhynchonella variabilis</i> , Schloth, and <i>Pentacrinus tuberculatus</i> , Mill.	
	10.	Dark shaly marls .....	2 0	<i>Ichthyosaurus platyodon</i> , Conyb.	
	11.	Gray limestone .....	0 6	Spines of <i>Pseudo-diadema</i> , and other <i>Echinidæ</i> .	
	12.	Dark indurated shale .....	3 6	<i>Ichthyosaurus platyodon</i> , Conyb.	
	13.	Bluish limestone .....	1 0	<i>Gryphæa incurva</i> , Sow., <i>Rhynchonella variabilis</i> , Schloth, and <i>Lima antiquata</i> , Sow.	
	14.	Dark shales, containing indurated imperfect limestone .....	1 6	<i>Ichthyosaurus communis</i> , Conyb., <i>I. platyodon</i> , Conyb., <i>Pentacrinus tuberculatus</i> , Mill., and <i>Lima gigantea</i> , Sow.	
	15.	Bluish limestone .....	0 10		
	16.	Dark indurated clay .....	1 3	<i>Gryphæa incurva</i> , Sow., and fragments of <i>Pentacrinus tuberculatus</i> , Mill.	
	17.	Gray limestone, with the plant-bed at the top .....	0 6	<i>Otopteris obtusa</i> , L. & H., and <i>Araucarites peregrinus</i> , Sternb., in the plant-bed.	
	18.	Dark-bluish limestone .....	1 6	<i>Ammonites Conybeari</i> , Sow., and <i>Rhynchonella variabilis</i> , Schloth.	
	19.	Dark shale .....	0 8	<i>Gryphæa incurva</i> , Sow.	

Am. Bucklandi or Lima Beds.	20.	Dark-grayish limestone.....	0 10	<i>Ammonites Bucklandi</i> , Sow., and <i>Am. rotiformis</i> , Sow.
	21.	Dark shale .....	0 8	
	22.	Gray limestone .....	0 4	
	23.	Dark shale .....	1 0	<i>Ichthyosaurus tenuirostris</i> , Conyb.
	24.	Dark-grayish limestone .....	1 4	<i>Ichthyosaurus communis</i> , Conyb., skulls and bones of other species, and <i>Rhynchonella variabilis</i> , Schloth.
	25.	Hard shale, forming "Quick Ledge" .....	1 6	<i>Ichthyosaurus communis</i> , Conyb., and <i>I. intermedius</i> , Conyb.
	26.	Blue limestone .....	0 6	<i>Ammonites Bucklandi</i> , Sow., and <i>Lima gigantea</i> , Sow.
	27.	Dark shale .....	0 8	<i>Gryphæa incurva</i> , Sow., and <i>Rhynchonella variabilis</i> , Schloth.
	28.	Concretionary limestone (surface mammillated) .....	0 4	
	29.	Dark-gray shale .....	0 8	<i>Ammonites angulatus</i> , Schloth.
	30.	Grayish limestone .....	0 6	<i>Lima gigantea</i> , Sow., and <i>L. antiquata</i> , Sow.
	31.	Dark indurated shale.....	0 9	<i>Ammonites angulatus</i> , Schloth (large specimens). <i>Gryphæa incurva</i> , Sow., small and dwarfed.
	32.	Hard gray limestone .....	0 7	<i>Lima gigantea</i> , Sow., and <i>L. antiquata</i> , Sow.

The shingle of the shore covers the lower beds.

*Coast of Glamorganshire.*—In Glamorganshire there is an extensive exposition of the *Am. Bucklandi* and *Lima* series for the distance of sixteen miles along the coast, from Penarth Head, by Barry Island, Aberthaw, and Dunraven Castle to the mouth of the River Ogmore, where the Lower Lias rests on upturned beds of Carboniferous Limestone. The strata chiefly laid bare by the sea are those containing *Lima gigantea* and *Gryphæa incurva*. At Cowbridge the same lithological relations are observed, and the Lower Lias here rests on Carboniferous Limestone.

At Penarth Head, however, the relation of the *Am. Bucklandi* series to the *Am. planorbis* and *Avicula contorta* beds is much better seen than at any other part of the Glamorganshire coast.

*Fossils of the zone of Ammonites Bucklandi.*—The fossils of the zone of *Ammonites Bucklandi* are numerous, and in general in a good state of preservation.

*Ichthyosaurus communis*, Conyb.  
— *intermedius*, Conyb.  
— *platyodon*, Conyb.  
— *tenuirostris*, Conyb.

*Ichthyodorulites* of Hybodus.

*Ammonites Bucklandi*, Sow.

— *Conybeari*, Sow.  
— *rotiformis*, Sow.  
— *angulatus*, Schloth.  
— *Greenoughii*, Sow.  
— *tortilis*, d'Orb.

*Nautilus striatus*, Sow.

*Pleurotomaria similis*, Sow.

*Ostrea irregularis*, Münst.

*Gryphæa incurva*, Sow.

*Unicardium cardioides*, Phil.

*Pecten textorius*, Schloth.

*Lima gigantea*, Sow.

— *antiquata*, Sow.

— *pectinoides*, Sow.

*Modiola Hillana*, Sow.

*Avicula Sinemuriensis*, d'Orb.



*Pinna diluviana* (Zieten, pl. 55, fig. 6).

*Pholadomya glabra*, Agass.

*Terebratula psilonoti*, Quenst.

*Rhynchonella variabilis*, Schloth.

*Spirifera Walcottii*, Sow.

*Pseudo-diadema* (spines).

*Cidaris Edwardsii*, Wr.

*Pentacrinus tuberculatus*, Mill.

*Isastræa Murchisoni*, Wr.

### 3. THE ZONE OF AMMONITES TURNERI.

*Synonymus*.—"Hauptpentacrinitenbank des untern Lias," Quenstedt, 'Flözgeb.,' p. 152, 1843. "Lumachelle de *Pentacrinites basaltiformis*," Marcou, 'Jura salinois,' p. 47, 1846. "Die Schichten des *Pentacrinus tuberculatus*" Oppel, 'Juraformation,' p. 44, 1856. "Tuberculatus-bed," Wright, 'Quart. Journ. Geol. Soc.,' vol. xv, p. 25, 1858. "Marne de Strassen," Dewalque et Chapuis, 'Fossiles de Luxembourg,' 1853. "Marne de Strassen," Dewalque, 'Descrip. du Lias de Luxembourg,' 1857. Zone of *Ammonites Turneri*, Wright, 'Quart. Journ. Geol. Soc.,' vol. xvi. p. 403.

This subdivision of the Lower Lias forms a well-marked zone of life. The beds consist of light-coloured argillaceous limestone, of hard grayish limestone, or of deep-blue, shelly, indurated shale, interstratified with beds of dark-coloured clay. Many of the slabs of limestone are covered with shells and portions of the stem and side arms of *Pentacrinus tuberculatus*, Mill. From one of these slabs, collected at Frethern or Purton, in Gloucestershire, Miller's original specimen of this Crinoid was obtained.

*Gloucestershire and Warwickshire*.—The zone of *Ammonites Turneri* was exposed at Bredon, in the deep cuttings of the Bristol and Birmingham Railway, from whence many of my specimens were obtained. In the Vale of Gloucester portions of these beds are sometimes laid open in making drains, as at Badgeworth and Hardwick; and many fine slabs are occasionally procured from the river-section at Purton. I know of no locality in Gloucestershire, where the entire series is exposed. My friend, Dr. Oppel, referred the Saurian beds of Bickeridge Common to this series, supposing them to be the equivalent of the Saurian beds at Lyme, which, however, appertain to the zone of *Ammonites Turneri*; the description I have already given of the *Am. planorbis* beds and their correlations prove that the beds at Bickeridge Common represent the *Am. planorbis* series. In Warwickshire the *Am. Turneri* beds constitute the base of what is called in that county the "Cardinia-series," in which are included all the strata of the Lower Lias between the *Am. Turneri* and *Am. raricostatus* beds, and which are characterised by different forms of the genus *Cardinia*.

*Dorsetshire*.—At Lyme Regis the *Ammonites Bucklandi* or *Lima* series is overlain by thick beds of clay and slaty marls containing many Enaliosaurian skeletons, with numerous fishes, in fine preservation; these strata are known to local collectors as the Fish- and

Saurian-beds. The magnificent specimen of *Ichthyosaurus platyodon*, Conyb., now in the British Museum, came from this clay, as is proved by the impressions of *Am. semicostatus*, Y. & B., which are seen on the matrix. This thick clay-bed is underlain by a thin band of grayish-limestone, in which *Am. Turneri* is found. The following section of this zone at Lyme Regis shows the sequence of the *Am. Turneri* beds at that locality.

*Section of the Zone of Ammonites Turneri at Lyme Regis.*

LITHOLOGY.		ORGANIC REMAINS.		
No.		ft.	in.	
Beds with <i>Ammonites Turneri</i> .	1. Thick limestone, "Broad Ledge"	3	6	<i>Ichthyosaurus platyodon</i> , Conyb., <i>I. communis</i> , Conyb., <i>Ammonites semicostatus</i> , <i>Am. Turneri</i> , Sow., and Fishes.
	2. Black shales, with bands of brown clay. "Saurian- and Fish-bed" .....	18	0	
	3. Grayish, hard, shelly limestone ...	0	4	<i>Ammonites Turneri</i> , Sow., and <i>Am. semicostatus</i> , Y. & B.
	4. Dark shales, with indurated bands of imperfect limestone .....	3	0	
	Grayish limestone .....			<i>Lima gigantea</i> , Sow., <i>L. antiquata</i> , Sow., and <i>Rhynchonella variabilis</i> , Schloth.
Beds with <i>Am. Bucklandi</i> and <i>Lima gigantea</i> . (See p. 68.)				

*Fossils of the Zone of Ammonites Turneri.*<sup>1</sup>

<i>Ichthyosaurus platyodon</i> , Conyb. (British Museum).	<i>Cardinia ovalis</i> , Stutch.
— <i>intermedius</i> , Conyb. (Warwick Museum).	<i>Ostrea</i> .
— <i>communis</i> , Conyb. (British Museum).	<i>Avicula inæquivalvis</i> , Sow.
<i>Ammonites Turneri</i> , Sow.	<i>Pecten textorius</i> , Schloth.
— <i>semicostatus</i> , Y. & B.	— <i>glaber</i> , Hehl.
— <i>Bonnardi</i> , d'Orb.	<i>Astarte consobrina</i> , Dewal.
<i>Turbo</i> .	<i>Crenatula</i> , nov. sp.
<i>Lima punctata</i> , Sow.	<i>Plicatula spinosa</i> , Sow.
— <i>gigantea</i> , Sow.	<i>Gervillia lanceolata</i> , Sow.
— <i>pectinoides</i> , Sow.	<i>Gryphæa incurva</i> , Sow.
	<i>Cidaris Edwardsii</i> , Wr.
	<i>Pseudodiadema spines</i> .
	<i>Pentacrinus tuberculatus</i> , Miller.

<sup>1</sup> I have omitted the fossil Fishes found in the Lias at Lyme Regis, as I was unable to ascertain with sufficient accuracy the beds from which the different species were collected; a large majority of them, however, I believe, came from this zone of life.



## 4. THE ZONE OF AMMONITES OBTUSUS.

*Synonyms.*—"Marston-Marble," Sowerby, 'Min. Con. Suppl. Index,' vol. i, 1812. "Ammonite-bed (Lower Lias)," Murchison, 'Geol. of Cheltenham,' 2nd edit., p. 42, 1845. "Turneri-Thone," Quenstedt, 'Flözgeb. Württembergs,' p. 540. "Sable d'Aubange (pars infer.)," Dewalque et Chapuis, 'Luxembourg,' p. 12. "Grès de Virton (pars infer.)," Dewalque, 'Lias de Luxembourg,' p. 48. "Die Schichten des *Ammonites obtusus*," Oppel, 'Juraformation,' p. 50. "Indurated marl and limestone-beds," De la Beche, "Section," &c., 'Geol. Trans.,' 2nd ser., vol. ii. Zone of *Ammonites obtusus*, Wright, 'Quart. Journ. Geol. Soc.,' xvi, p. 404.

*Gloucestershire and Warwickshire.*—The beds constituting this zone are well developed in the Vale of Gloucester, and were exposed in the deep cuttings of the Bristol and Birmingham Railway, especially near Bredon, from whence the best collection of the fossils of these beds was obtained. The rocks consist of dark-gray or bluish shales and clays, with irregular and inconstant beds of dark-gray argillaceous limestone, the shales being in parts nodular or laminated, the clays thick and tenacious; the nodular portions of the shales were very fossiliferous. This zone forms part of the Cardinia-bed of the local geologists of Warwickshire, where it appears to be exposed in several localities. Mr. Tomes' collection contains some very fine specimens of *Ammonites obtusus*, *Am. multicosatus*, *Am. Brookii*, and *Am. Sauzeanus*, d'Orb., obtained from the *Am. obtusus* beds; and Mr. Kershaw's cabinet contains a series of *Am. Sauzeanus*, d'Orb., from Darlingstoke, near Shipton-on-Stour. Mr. Etheridge has collected this species at Horfield, near Bristol.

*Dorsetshire.*—At Lyme Regis the zone of *Ammonites obtusus* attains a considerable thickness, and is well shown in the coast-section. The strata rise on the shore about half a mile west of Charmouth, they consist of thick beds of dark marls, which rest upon the Table-bed, formed by Broad Ledge. The lower part of these marls contains numerous compressed *Ammonites Birchii*, Sow., and layers of nodules forming cement-stones. Above these succeed shales and clays, thin bands of limestone, and thick beds of shale and marls with mudstones. Above these again are inconstant bands of limestone containing septaria, in which gigantic examples of *Am. obtusus*, *Am. stellaris*, and *Am. Brookii* are found. The following section shows the relative position of these beds.

*Section from Broad Ledge to Cornstone Ledge, near Charmouth.*

LITHOLOGY.		ORGANIC REMAINS.	
No.	ft. in.		
1. Dark-gray limestone. "Cornstone Ledge."			
2. Dark-bluish marls .....	20 0		
2. Dark-grayish limestone .....	0 10	<i>Ichthyosaurus platyodon</i> , Conyb., and <i>I. intermedius</i> , Conyb. <i>Ammonites Birchii</i> , Sow.	
4. Dark clays.			
5. Dark limestone, with septaria.		<i>Nautilus striatus</i> , Sow., <i>Ammonites Brookii</i> , Sow., and <i>Am. stellaris</i> , Sow. (very large).	
6. Dark shale.			
7. Dark limestone. "Upper Cement-bed."			
8. Dark shales, containing mudstone nodules at the base.		<i>Scelidosaurus Harrisonii</i> , Owen. <i>Inoceramus</i> .	
9. Thin band of limestone. The "Pentacrinite-bed."		<i>Extracrinus Briareus</i> , Mill.	
10. Dark shales.	} "Fire-ledge."		
11. Dark limestone.			
12. Dark shale.			
13. Dark limestone.	} "Split-ledge."		
14. Dark shale.			
15. Dark limestone .....		<i>Ammonites planicosta</i> , Sow., and <i>Am. Smithii</i> , Sow.	
16. Dark shales .....		Saurian skeletons.	
17. Grayish limestone .....		<i>Ammonites obtusus</i> , Sow., and <i>Am. Birchii</i> , Sow., crystallised, forming the "Tortoise-ammonites."	
18. Dark marls, with nodular masses .....	20 0	The nodules of these lower Cement-beds contain Saurian remains. <i>Pentacrinus</i> , n. sp.	
19. Dark indurated shale and limestone. "Broad Ledge" .....	4 0	This bed overlies the Lima-series east of Lyme-Regis.	

The zone of *Ammonites obtusus* probably attains a thickness of from 80 to 100 feet; its actual measurement would be a matter of difficulty, from the manner in which the marls have covered over the bands of limestone; hence the imperfection of our estimate.

In the lower slaty marls are numerous compressed *Ammonites Birchii*, which fall to pieces when removed from the matrix. Higher up (No. 17) the same species is found in fine preservation, with *Ammonites obtusus*. Here the shells are replaced, and the septa filled, with crystallised carbonate of lime. These beautiful specimens are the "Tortoise-ammonites" of local collectors. About 40 or 50 feet above the latter an irregular band of limestone (5) is seen projecting from the cliff, which contains nodules with very large specimens of *Ammonites obtusus*, Sow., *Am. stellaris*, Sow., and *Am. Brookii*, Sow. Most of the nodules have a septarian structure, the veins of spar intersecting and distorting the form of the Ammonites.

Below the Ammonitiferous nodules (5 of the section) other bands of clay and marl (6 to 14) succeed. In one of these (9) are thin layers of Crinoidal limestone, on the surface of which magnificent specimens of *Extracrinus Briareus*, Mill., are found, with their plant-like arms laid out in all directions, and generally coated with sulphuret of iron. The remarkable Liassic Dinosaurian *Scelidosaurus Harrisonii*, Ow., so fully figured and described in the Palæontographical Society's volume for 1859 was discovered some years ago by Mr. Samuel Clarke, of Charmouth, in the dark shales of bed No. 8, above the mudstones.

*Fossils of the Zone of Ammonites obtusus.*

<i>Scelidosaurus Harrisonii</i> , Owen.	<i>Ammonites Smithii</i> , Sow.
<i>Ammonites obtusus</i> , Sow.	— <i>Birchii</i> , Sow.
— <i>Brookii</i> , Sow.	<i>Nautilus striatus</i> , Sow.
— <i>stellaris</i> , Sow.	<i>Belemnites acutus</i> , Mill.
— <i>planicosta</i> , Sow.	<i>Pleurotomaria Anglica</i> , Sow.
— <i>Dudressieri</i> , d'Orb.	<i>Inoceramus</i> , n. sp.
— <i>Sauzeanus</i> , d'Orb.	<i>Extracrinus Briareus</i> , Mill.

5. THE ZONE OF AMMONITES OXYNOTUS.

*Synonyms*.—"Oxynoten-Schichte," Fraas, 'Württemberg. naturw. Jahreshäfte,' 1847, p. 206. "Oxynotenlager," Quenstedt, 'der Jura,' p. 293, 1858. "Die Schichten des *Ammonites oxynotus*," Oppel, 'die Juraformation,' p. 54, 1856. "Oxynotus-bed," Wright, 'Quart. Journ. Geol. Soc.,' vol. xiv, p. 25, 1858. "Zone of *Ammonites oxynotus*," Wright, 'Quart. Jour. Geol. Soc.,' 1860, vol. xvi, p. 406.

In Gloucestershire this zone consists of beds of dark clays, which often contain much sulphuret or peroxide of iron, all the fossils found in the clay being either highly pyritic or charged with the peroxide of that metal. This bed was exposed in the cuttings of the Bristol and Birmingham, and Great Western Railways, at Lansdown, near Cheltenham, and in excavating the new docks at Gloucester; I have likewise collected its characteristic fossils at other localities in the Vale of Gloucester.

In Dorsetshire a variety of *Ammonites oxynotus*, Quenst., is found in a thin bed of dark, pyritic marl between Charmouth and Lyme Regis, near Black Venn. It is here collected with other species, which properly belong to a higher bed; the falling down of the upper marl, by the decay of the bank, makes it difficult to separate the beds.

At Robin Hood's Bay, on the Yorkshire coast, the relative position of this zone to the beds with *Ammonites obtusus*, Sow., below, and *Ammonites varicostatus*, Ziet., above, are seen in the cliff near the point where the road leads up to the Alum-works. At this locality the *Am. oxynotus* bed is about 20 feet above the clays with *Am. obtusus*.

The form of *Ammonites oxynotus*, Quenst., collected near Cheltenham, exactly resembles the original type of this Ammonite found in Würtemberg. I possess a series of this



species, kindly sent me in exchange, from the Royal Museum of Stuttgart, by Professor Fraas which could not be distinguished from ours if they were not previously marked for identification.

*Fossils of the Zone of Ammonites oxynotus.*

Ammonites oxynotus, <i>Quenst.</i>	Plicatula ventricosa, <i>Münst.</i>
— bifer, <i>Quenst.</i>	Modiola minima, <i>Sow.</i>
— lacunatus, <i>Buck.</i>	Arca oxynoti, <i>Wr.</i> , n. sp. .
Nautilus striatus, <i>Sow.</i>	Leda Romani, <i>Oppel.</i>
Belemnites acutus, <i>Mill.</i>	Acrosalenia minuta, <i>Buck.</i>
Pleurotomaria Anglica, <i>Sow.</i>	Muricated spines of <i>Cidaris.</i>

6. THE ZONE OF AMMONITES RARICOSTATUS.

*Synonyms.*—"Hippopodium-bed (in part)," Murchison's 'Geology of Cheltenham,' 2nd ed., by Buckman and Strickland, p. 44. "Raricostatenschicht," Fraas, 'Württemb. naturw. Jahreshfte,' 1847, pl. 3. "Raricostatenbank," Quenstedt, 1856, 'der Jura,' p. 292. "Die Schichten des *Ammonites raricostatus*," Oppel, 1856, 'die Juraformation,' p. 56. "Raricostatus-bed," Wright, 'Quart. Jour. Geol. Soc.,' vol. xiv, p. 25. "Zone of *Ammonites raricostatus*," Wright, 'Quart. Jour. Geol. Soc.,' vol. xvi, p. 407.

The beds forming this zone are exposed in several brick-fields in the vicinity of Cheltenham. They consist of dark-coloured clays, more or less impregnated with the peroxide of iron. In an excavation recently made near Marle Hill, for the purpose of obtaining clay to make bricks for the town-sewers, the following section was obtained. The beds are enumerated in descending order.

No.	ft.	in.
1. <i>Gryphæa-bed</i> ; a hard, ferruginous clay, which broke into fragments, and contained a great many specimens of <i>Gryphæa obliquata</i> , Sow. ....	3 ft.	to 4 0
2. <i>Coral-band</i> ; a thin seam of lightish-coloured, unctuous clay, containing a great many small, sessile Corals, <i>Thecocyathus rugosus</i> , Wr., most of which appeared to have been attached to the curved valves of the <i>Gryphææ</i> .....	1 in.	to 0 1½
3. <i>Hippopodium-bed</i> ; a stiff, dark-coloured clay, in some parts ferruginous; containing <i>Cardinia Listeri</i> , Sow., and <i>Hippopodium ponderosum</i> , Sow., in considerable numbers.....	from 8 ft.	to 10 0
4. <i>Ammonite-bed</i> ; a dark, ferruginous clay, containing selenite, with the peroxide and sulphuret of iron, and great numbers of a highly pyritic brood of <i>Ammonites</i> , likewise <i>Am. raricostatus</i> , <i>Am. armatus</i> , and the other species of the list .....	} Not ascertained.	

In the parish of Cleeve, near Cheltenham, the same beds were formerly worked for

brick-earth; the finest specimens I have collected of *Cardinia Listeri*, Sow., *Hippopodium ponderosum*, Sow., *Ammonites raricostatus*, Ziet., and *Pleurotomaria Anglica*, Sow., were obtained therefrom. In the railway-cutting at Bredon the same beds were likewise laid open, and yielded a rich series of the characteristic fossils. In Warwickshire the railway-cutting at Honeybourne exposed the same beds; and here also the Coral-band contained a considerable number of *Thecocyathus rugosus*, Wr.

At Lyme Regis, in Dorsetshire, this zone is found near Black Venn. Some of the beds contain a considerable quantity of pyrites, so much so that during the winter months they are worked for that mineral, when their characteristic *Ammonites* are collected in considerable numbers; unfortunately these fossils are so much charged with pyrites that they are with difficulty preserved.

At Robin Hood's Bay, on the coast of Yorkshire, this zone is seen resting on the underlying clays with *Ammonites oxynotus*, and overlain by thick clays containing *Ammonites Jamesoni*, Sow. In all these localities there appears to be an absence of limestone-layers; clay, more or less impregnated with iron, constituting the entire beds.

*Fossils of the Zone of Ammonites raricostatus.*

<i>Belemnites acutus</i> , Mill.	<i>Ostrea, raricostata</i> , Wr.
<i>Nautilus striatus</i> , Sow.	<i>Gryphæa obliquata</i> , Sow.
<i>Ammonites raricostatus</i> , Ziet.	<i>Cardinia Listeri</i> , Sow.
— <i>armatus</i> , Sow.	<i>Hippopodium ponderosum</i> , Sow.
— <i>armatus densinodus</i> , Quenst.	<i>Anomya pellucida</i> , Terq.
— <i>nodulosus</i> , Buck.	<i>Unicardium cardioides</i> , Phil.
— <i>Guibalianus</i> , d'Orb.	<i>Pleuromya oblonga</i> , Wr., n. sp.
— <i>muticus</i> , d'Orb. (?)	<i>Rhynchonella variabilis</i> , Schloth.
<i>Pleurotomaria similis</i> , Sow.	<i>Terebratula numismalis</i> , Lamk.
<i>Trochus imbricatus</i> , Sow.	<i>Pentacrinus scalaris</i> , Goldf.
<i>Chemnitzia parva</i> , Wr., n. sp.	<i>Thecocyathus rugosus</i> , Wr.

THE MIDDLE LIAS.

The Middle Lias is well developed in England, and fully exposed in the grand natural sections of the Yorkshire and Dorsetshire coasts. In the Midland Counties it is only partially shown. I therefore select a section of the cliffs east of Charmouth, Dorset, which I made for this work last summer, with the assistance of my friend Mr. Day, as the one that affords the best general view of the whole; the Middle Lias here attains a thickness of about 450 feet, and is divisible into five stages, each characterised by special specific forms; these in ascending order are—1st. The zone of *Ammonites Jamesoni*. 2nd. The zone of *Ammonites Ibez*. 3rd. The zone of *Ammonites capricornus*. 4th. The zone of *Ammonites margaritatus*. 5th. The zone of *Ammonites spinatus*.

*Section of Down Cliffs, at Toad's Cove, near Bridport Harbour.*

Elevation.	LITHOLOGY.	Thickness. feet.	ORGANIC REMAINS.
400 ft.	ZONE OF AMMONITES JURENSIS.		
No.			
	1. Brown sands, sometimes micaceous, with large sandstone nodules in layers	70	<i>Ammonites opalinus</i> , Rein., at Burton Cliff.
	ZONE OF AMMONITES COMMUNIS.		
	2. Dark-grayish sandy marl, very mica- ceous .....	72	Fossils rare, and indeterminable.
300 ft.	3. Brownish marly limestone, containing great numbers of <i>Ammonites ser- pentinus</i> and other Upper Lias shells. The Middle Lias comes up to the lower part of this band of stone, for <i>Ammonitus spinatus</i> has been found in it by Mr. Day.....	2½	<i>Ammonites serpentinus</i> , Schlot., <i>A. communis</i> , Sow., <i>A. bifrons</i> , Brug., <i>Raquinianus</i> , d'Orb., <i>Pleuromya unioides</i> , Roem., <i>Venus</i> <i>pumila</i> , Münster., <i>Rhynch. acuta</i> , Sow., and <i>Rhynch. Moorei</i> , Dav.
	ZONE OF AMMONITES SPINATUS.		
	4. Dark-gray, sandy, micaceous marl .....	18	<i>Ammonites spinatus</i> , Brug. <i>Belemnites brevi- formis</i> , Ziet.
	5. Indurated sand, forming large sand- stone blocks .....	8	
	6. Light-brown sands, more or less indu- rated, and very micaceous.....	56	Found no fossils to enable us to determine whether the bed belongs to this, or the lower zone.
200 ft.	ZONE OF AMMONITES MARGARITATUS.		
	7. Bluish marl, which forms a well- defined band in the section .....	6—8	
	8. Grayish, sandy, laminated marls, with irregular layers of nodules.....	20	<i>Ammonites margaritatus</i> , Mont., <i>Am. fimbri- atus</i> , Sow., <i>Belemnites elongatus</i> , Mill., <i>Pleurotomaria Anglica</i> , Sow., <i>P. expansa</i> , Sow., <i>Pleuromya unioides</i> , Roem., <i>Pecten</i> <i>æquivalvis</i> , Sow., <i>Limea acuticostata</i> , Münst., <i>Lima Hermannii</i> , Münster., <i>Pinna</i> <i>Hartmanni</i> , Münster., <i>Rhynchonella acuta</i> , Sow., <i>R. tetrahædra</i> , Sow., <i>R. spinosa</i> , ? Schloth., <i>Gryphæa gigantea</i> , Sow.
	9. Foxy-coloured sandstone, with from 12—16 irregular bands of stone form- ing the "rough bed" of the workmen	40	
	10. Band of Crinoidal limestone .....		<i>Pentacrinus subangularis</i> , Mill.
	11. Gray sandy clay, in parts micaceous...	20	
100 ft.	Band of ferruginous septariæ.		
	12. Gray laminated sandy clay.....	17	



Elevation.	LITHOLOGY.	Thickness. feet.	ORGANIC REMAINS.
No.			
13.	The "Starfish Bed," hard, gray, micaceous sandstone, large blocks from this bed lie on the shore.....	6	<i>Ophioderma Egertoni</i> , Brod., <i>Ammonites fimbriatus</i> , Sow., <i>A. margaritatus</i> , Mont., <i>Belemnites elongatus</i> , Mill.
ZONE OF AMMONITES CAPRICORNUS.			
14.	Gray marls, breaking up into cuboidal masses; in the upper part are several rows of small, fossiliferous nodules; this bed is much thicker, and better seen at Golden Cap.....	76	<i>Ammonites capricornus</i> , Schloth., <i>A. Henleyi</i> , Sow., <i>A. Bechei</i> , Sow., <i>A. Davæi</i> , Sow.
	Base of Down Cliffs .....		

The gray or micaceous marls attain a great thickness at Golden Cap, where they rest on the Belemnite bed. These marls contain several stages of life, which have not been worked out with sufficient accuracy, to enable me to define the limits of the different zones. Fragments of *Ammonites Jamesoni* have been collected in the lower part of this deposit, and *Ammonites Davæi*, *capricornus*, and *Bechei*, in the upper. In Gloucestershire beneath the zone of *Ammonites capricornus* two other zones are found characterised by *Ammonites Ibeæ* and *Ammonites Jamesoni*, and these are likewise doubtless comprised in the gray, micaceous marls at Golden Cap, which here attain so great a thickness.

#### 7. THE ZONE OF AMMONITES JAMESONI.

*Synonyms*.—"Micaceous marl, in part," De la Beche's section. "Numismalismergel oder Belemnitenmergel," Quenstedt, 'das Flötzgebirge Württemberg.' "Lias Gamma, pars," Quenst., 'der Jura Uebersichtstafel,' p. 293. "Die Schichten des *Ammonites Jamesoni*," Oppel, 'die Juraformation,' p. 118. "Jamesoni-bed," Wright, 'Quart. Jour. Geol. Soc.,' vol. xiv, p. 25.

In Gloucestershire the beds representing this zone are found only in some deep brick-pits near Leckhampton, in the environs of Cheltenham, from whence I obtained fragments of a large *Ammonites Jamesoni*, Sow., and many of the young forms of this species known as *A. Bronni*, Röm., with *Rhynchonella rimosa*, von Buch.

The same Ammonites are found at Robin Hood's Bay, on the coast of Yorkshire, where these beds at the west of the bay, according to Dr. Oppel, attain a thickness of 100 feet; with *Ammonites Jamesoni* were associated *Ammonites Taylora*, Sow., *Bel. elongatus*, Mill., *Gryphæa obliquata*, Sow., *Pholadomya decorata*, Ag., and *Pinna folium*, Phil.

This zone is well developed in the Island of Pabba, near Skye, in the Hebrides, where *Ammonites Jamesoni* is moderately abundant, if I may form an opinion from the number of

specimens of that Ammonite collected at Pabba by Mr. Geikie<sup>1</sup> in a brown, micaceous sandstone, and which have passed through my hands for determination.

The original type of this Ammonite was collected by Sir R. Murchison from beds of the same age in the adjacent Isle of Mull.

In Dorsetshire this Ammonite is occasionally found; I have not seen a specimen, nor have I been able to determine its bed.

#### 8. THE ZONE OF AMMONITES IBEX.

*Synonyms.*—"Ochraceous Lias," Murchison, 'Geol. of Cheltenham,' 2nd edit., 42. "Die Schichten des *Ammonites Ibex*," Oppel, 'die Juraformation,' p. 122. "Upper marls, pars," De la Beche, 'Geol. of Lyme Regis.' "Ibex-bed," Wright, 'Quart. Jour. Geol. Soc.,' vol. xiv, p. 25.

In the neighbourhood of Cheltenham this zone is often exposed, and from hard, calcareous nodules, imbedded in a light-coloured clay, its characteristic Ammonites are collected; these are *Ammonites Ibex*, Quenst., *A. Maugenessi*, d'Orb., and *A. Henleyi*, Sow., *A. bipunctatus*, Röm., with several Conchifera, as *Crenatula ventricosa*, Sow., *Mytilus scalprum*, Sow., *Arca elongata*, Quenst., *Pinna folium*, Y. and B., *Cardinia attenuata*, Buck., and many other undescribed forms.

In Northamptonshire fine specimens of *A. Ibex*, Quenst., and *A. bipunctatus*, Röm., have been collected near Watford.

#### 9. THE ZONE OF AMMONITES CAPRICORNUS.

*Synonyms.*—"Lias Gamma (pars Davæikalk)," Quenstedt, 'der Jura Uebersichtstafel,' p. 293. "Schiste d'Ethe," Dewalque, 'Lias de Luxembourg,' p. 55. "Die Schichten des *Ammonites Davæi*," Oppel, 'Juraformation,' p. 126. "Davæi-bed," Wright, 'Quart. Jour. Geol. Soc.,' vol. xiv, p. 25.

This zone is very well developed in England; and wherever the Middle Lias is complete it is found beneath the marlstone, consisting of laminated clays, containing micaceous particles, or the argile is richly charged with peroxide of iron, whilst in other localities it is represented by a brown, micaceous sandstone. The irregular, stony bands found in the clay usually contain a large assemblage of fossils. This zone is likewise especially rich in the remains of Echinodermata, and claims our special interest on that account.

<sup>1</sup> 'Quart. Journ. of the Geol. Soc.,' vol. xiv, p. 28.

At Mickelton<sup>1</sup> tunnel the shale which lies below the marlstone was exposed to a considerable extent, and yielded a great number of fossils in a high state of preservation. The shales were in parts arenaceous, and formed thin slabs of a fine, bluish sandstone, on which many of the Echinodermata were found. There were also large slabs of ironstone, sixteen inches in thickness, almost entirely composed of shells; the upper and under surfaces in many of them were crowded with fragments of *Pentacrinites* and skeletons of *Asteriadæ*. *Uraster Gaveyi*, Forb., figured in our plate, was discovered on the upper surface of a slab of sandstone, twelve inches in thickness, associated with plates and fragments of *Pentacrinus robustus*, Wr., and several of the Conchifera of the subjoined list, together with compressed shells of *Ammonites capricornus*, Schloth.

All the specimens of *Tropidaster pectinatus*, Forb., *Ophioderma Gaveyi*, Wr., and *Cidaris Edwardsii*, Wr., were found attached to the under side of a thick slab of ironstone, about twenty feet below the surface. Almost all the specimens show their ventral surface, and most of them have their spines fixed on the spiniferous tubercles to which they belonged; several of the star-fishes are as well preserved for anatomical description as if they had been prepared from recent specimens for that purpose.

Beds of laminated shale and ferruginous clay, the equivalent in age of those at Mickelton, were cut through in making the deep excavations on Hewlett's Hill for the formation of the reservoirs of the Cheltenham Waterworks Company. In the laminated clays the shells of the Mollusca and the tests of the Echinodermata were well preserved, but the fossils in the ferruginous clay, although very abundant, soon perished from the large per-centage of iron which the argile contained.

The same bands of rock were likewise laid open at Witcombe Park, near Birdlip. In constructing the reservoir for receiving the water flowing from the Witcombe Spring for the supply of the City of Gloucester, the fossils were abundant, but mostly fragmentary. In many the shell was preserved, and some fine specimens of *Nautilus striatus* were obtained.

*Fossils from the Zone of Ammonites capricornus, in Gloucestershire.*

CEPHALOPODA.

Belemnites umbilicatus, <i>d'Blanc.</i>	Ammonites Henleyi, <i>Sow.</i>
— elongatus, <i>Mill.</i>	— capricornus, <i>Schloth.</i>
— paxillosus, <i>Schloth.</i>	— fimbriatus, <i>Sow.</i>
Nautilus striatus, <i>Sow.</i>	— Davæi, <i>Sow.</i>

GASTEROPODA.

Chemnitzia capricorni, <i>Wr., n. sp.</i>	Pleurotomaria Anglica, <i>Sow.</i>
Cylindrites capricorni, <i>Wr., n. sp.</i>	— expansa, <i>Sow.</i>
Trochus imbricatus, <i>Sow.</i>	— undosus, <i>Schübl.</i>

<sup>1</sup> "On the Railway Cuttings at the Mickleton Tunnel, &c.," by G. E. Gavey, Esq., with sections; 'Quart. Journ. Geol. Soc.,' vol. ix, p. 29.



## CONCHIFERA.

<i>Pholadomya ambigua</i> , <i>Sow.</i>	<i>Arca elongata</i> , <i>Quenst.</i>
— <i>decorata</i> , <i>Hartm.</i>	— <i>truncata</i> , <i>Buck.</i>
<i>Pleuromya unioides</i> , <i>Röm.</i>	<i>Modiola scalprum</i> , <i>Sow.</i>
<i>Leda rostralis</i> , <i>Lamk.</i>	<i>Limea acuticosta</i> , <i>Gold.</i>
— <i>complanata</i> , <i>Röm.</i>	<i>Avicula longiaxis</i> , <i>Buck.</i>
— <i>acuminata</i> , <i>Goldf.</i>	<i>Monotis inæquivalvis</i> , <i>Sow.</i>
— <i>cordata</i> , <i>Goldf.</i>	<i>Inoceramus ventricosus</i> , <i>Sow.</i>
— <i>inflexa</i> , <i>Röm.</i>	— <i>substriatus</i> , <i>Goldf.</i>
<i>Astarte capricorni</i> , <i>Wr.</i>	<i>Pecten æquivalvis</i> , <i>Sow.</i>
<i>Mytilus hippocampus</i> , <i>Young and Bird.</i>	— <i>priscus</i> , <i>Schloth.</i>
<i>Cypricardia cucullata</i> , <i>Goldf.</i>	— <i>diversus</i> , <i>Buck.</i>
<i>Cardinia attenuata</i> , <i>Stutch.</i>	— <i>liasius</i> , <i>Nyst.</i>
<i>Goniomya capricorni</i> , <i>Wr.</i>	<i>Gervillia lævis</i> , <i>Buck.</i>
<i>Cardium truncatum</i> , <i>Phil.</i>	<i>Plicatula spinosa</i> , <i>Sow.</i>
<i>Unicardium Janthe</i> , <i>d'Orbig.</i>	<i>Gryphæa cymbium</i> , <i>Lam.</i>
<i>Cucullæa Münsteri</i> , <i>Ziet.</i>	<i>Ostrea.</i>

## BRACHIOPODA.

<i>Terebratula punctata</i> , <i>Sow.</i>	<i>Rynchonella variabilis</i> , <i>Schloth.</i>
<i>Spirifer rostratus</i> , <i>Schloth.</i>	<i>Orbicula scaliforme</i> , <i>Wr.</i> , n. sp.
<i>Rynchonella rimosa</i> , <i>von Buch.</i>	<i>Lingula Beanii</i> , <i>Phil.</i>

## ECHINODERMATA.

<i>Cidaris Edwardsi</i> , <i>Wr.</i>	<i>Ophioderma Gaveyi</i> , <i>Wr.</i>
<i>Aerosalenia</i> , sp.	<i>Ophioderma Brodiei</i> , <i>Wr.</i> n. sp.
<i>Pedina</i> , sp.	<i>Pentacrinus robustus</i> , <i>Wr.</i>
<i>Uraster Gaveyi</i> , <i>Forb.</i>	— <i>punctiferus</i> , <i>Quenst.</i>
<i>Tropidaster pectinatus</i> , <i>Forb.</i>	— <i>subangularis</i> , <i>Mill.</i>

On the coast of Yorkshire, as at Staithes, Boulby, and Skinninggrave Bay, where the Marlstone series is admirably exposed, the shales with *Ammonites maculatus* (*capricornus*) form the base of the cliffs. "This Ammonite," observes Mr. Hunton,<sup>1</sup> "is constantly found at the junction of the Marlstone with the Lower Lias (zone of *A. capricornus*), which here pass so gradually into each other that it is impossible to determine where the sandstones end and the blue shale begins. I have long sought for *A. maculatus*, Y. & B., (*capricornus*, Schloth.) in the upper and central portions of the Marlstone, but have never found it many feet above the junction beds; and though this and other Ammonites from unequal geographical distribution may be more abundant in one place than in another (*A. maculatus* is in greatest number at Staithes, *A. Hawskerensis* at Hawskerbottoms), yet

<sup>1</sup> 'Trans. Geol. Soc.,' second series, vol. v, p. 218.

they constantly maintain an unvariable relative position." It was from the upper shales of this zone at Robin Hood's Bay that *Luidia Murchisonæ*, Will., was obtained, and from beds of the same age at Skinninggrave that *Plumaster ophiuroides*, Wr., was extracted. It would appear, therefore, that the northern limit of this stage in England is characterised by species of ASTERIIDÆ entirely distinct from those found in the south, although the species of the molluscan fauna are the same throughout.

On the Dorsetshire coast, as near Charmouth, this zone forms the upper portion of the gray micaceous marls, or "the green Ammonite-bed" of local collectors. The Charmouth form of *A. capricornus*, Schl., was figured by Sowerby in his 'Mineral Conchology,' vol. vi, pl. 556, fig. 2, as *A. latacosta*; and to increase the existing confusion regarding the identity of this species, a mistake was made in the text in reference to the figures—*A. latacosta* was described as *A. brevispina*, and *vice versâ*; this fact I have verified by an examination of the original specimens. *A. latacosta*, Sow., is therefore only a variety of *A. capricornus* from the upper portion of the gray marls, whilst *A. brevispina*, Sow., is a distinct species, which I have hitherto only detected among fossils from the zone of *Ammonites Jamesoni* at Pabba. In my description of *Ammonites brevispina*, Sow.,<sup>1</sup> it is stated—"Sowerby's text and the numbers of pl. 556 do not agree; this mistake will mislead the reader, unless he is acquainted with the two Ammonites figured in that plate, for fig. 1 represents *Amm. brevispina*, Sow., and fig. 2, *Amm. latacosta*, Sow.; the former is a Pabba, the latter a Charmouth, fossil.

*Ammonites Loscombi*, Sow., is a very abundant form, and which has a very wide range throughout the gray micaceous marls.

## 11. THE ZONE OF AMMONITES MARGARITATUS.

*Synonyms*.—"Marlstone and ironstone series," Phillips, 'Geol. of York,' p. 192. "The Marlstone," Murchison, 'Geol. of Cheltenham,' 2nd edit., p. 37. "Marlstone," Williamson, "Fossil Remains on the Yorkshire Coast," 'Geol. Trans.,' 2nd ser., vol. v, p. 224. "Marlstone," Hull, 'Memoirs of the Geol. Survey,' descrip. of sheet 44, p. 18. "Lias Delta, Amaltheenthon," Quenstedt, 'Flözgeb.,' p. 540. "Marnes à *Ammonites amaltheus* ou *margaritatus*," Marcou, 'Jura Salinois,' p. 50. "Macigno d'Aubange," Dumont, Dewalque et Chapuis, 'Luxembourg,' p. 273. "Die oberen Schichten des *Ammonites margaritatus*," Oppel, 'Juraformation,' p. 133. "Margaritatus-bed," Wright, 'Quart. Journ. Geol. Soc.,' vol. xv, p. 25.

The Marlstone forms a well-known division of the Lias formation. In Gloucestershire it consists, according to Mr. Hull,<sup>2</sup> of two parts—the lower, a series of yellow, gray, and brown sands, with thin bands of calcareous limestone and ferruginous nodules; the

<sup>1</sup> 'Quart. Journ. Geol. Soc.,' vol. xiv, p. 28.

<sup>2</sup> 'Memoirs of the Geol. Survey. The Country around Cheltenham,' p. 18.

upper, a rock-bed of an impure limestone, weathering blue or brown in the interior. In the eastern part of the district it is highly ferruginous, and varies from one to ten feet in thickness. The rock-bed forms the surface of the tabulated promontories which produce such picturesque features along the flanks of the Cotteswold Hills, and around many of the outliers, while the steep, fertile banks which descend from the edges of the platforms to the Lower Lias plain are composed of the underlying beds of sand.

At Leekhampton Hill the thickness of this formation is 115 feet, and this is its estimated general thickness around the Cotteswold Hills. The zone of *Ammonites spinatus* is so closely incorporated with the Marlstone rock-bed that it must be included in this stage, of which it forms the uppermost portion.

*Fossils from the Marlstone.*

VERTEBRATA.

Vertebræ of Ichthyosaurus.

Teeth and scales of fishes.

CEPHALOPODA.

Belemnites compressus, *Stahl.*

— paxillosus, *Schloth.*

Nautilus striatus, *Sow.*

— intermedius, *Sow.*

Ammonites margaritatus, *Montf.*

— Englehardti, *d'Orbig.*

— Normanianus, *d'Orbig.*

— heterophyllus amalthei, *Quenst.*

GASTEROPODA.

Pleurotomaria Anglica, *Sow.*

— undosus, *Schübl.*

— expansa, *Sow.*

Chemnitzia undulata, *Ziet.*

Turbo orion, *d'Orbig.*

Trochus imbricatus, *Sow.*

CONCHIFERA.

Pholadomya ambigua, *Sow.*

Pleuromya unioides, *Röm.*

— rotundata, *Goldf.*

— Alduini, *Brong.*

— donaciforme, *Goldf.*

Ceromya lineata, *Will.*

Arcomya elongata, *Röm.*

Unicardium cardioides, *Phil.*

Cardium truncatum, *Phil.*

Cardinia crassiuscula, *Sow.*

— crassissima, *Sow.*

Goniomya capricorni, *Wr.*

Cypricardia encullata, *Goldf.*

Modiola scalprum, *Sow.*

Limea acuticosta, *Goldf.*

Monotis inæquivalvis, *Sow.*

Lima Hermannii, *Voltz.*

— duplicata, *Sow.*

— pectinoides, *Sow.*

Pecten diversus, *Buck.*

— æquivalvis, *Sow.*

— cinctus, *Sow.*

Gryphæa gigantea, *Sow.*

Ostrea.



## BRACHIOPODA.

Terebratula punctata, Sow.	Rhynchonella tetrahedra, Sow.
— resupinata, Sow.	— variabilis, Schloth.
— cornuta, Sow.	— acuta, Sow.
— Edwardsii, David.	Lingula Beanii, Phil.

## ECHINODERMATA.

Hemipedinia Jardinii, Wr.	Pentacrinus subangularis, Mill.
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The Marlstone attains a great development in Yorkshire, and is fully exposed in the coast section near Staithes. "The sandy, conchiferous marlstone beds," says Prof. Phillips,<sup>1</sup> "which in Colborn Nab cover the Lower Lias shale, are seen rising with it and contributing to swell the altitude of Boulby and Rockcliff. The lower part of this series is generally the most solid, and projects in broad, compact floors above the Lias. On the surfaces of such beds lie innumerable multitudes of Oysters, Dentalia, Pectens, *Cardium truncatum*, *Avicula inæquivalvis*, and, more rarely about Staithes, beautiful fossil star-fishes of the genus *Ophiura*." In Boulby Cliffs<sup>2</sup> the ironstone and Marlstone series consists of—

a. The ironstone bands, which are numerous layers of firmly connected nodules of ironstone, often septiarate, and enclosing dicotyledonous wood, Pectines, Aviculæ, Terebratulæ, and from twenty to forty feet thick.

b. The Marlstone series, consisting of alternations of sandy Lias shale and sandstones, which are frequently calcareous, and generally full of shells. The lower beds are usually most solid, and project from the cliffs in broad floors, covered with Pectens, Cardia, Dentalia, Aviculæ, Gryphææ, &c. The thickness variable from forty to 120 feet.

The molluscan fauna of these beds closely resembles the list already given from the Marlstone of Gloucestershire. Among the Echinodermata, however, are found species which appear to be limited to the Yorkshire series, as *Uraster carinatus*, Wr., *Astropecten Hastingsiæ*, Forb., *Ophioderma Milleri*, Phil., *Aspidura loricata*, Will., and *Ophiura Murravii*, Forb., all collected from the Marlstone series near Staithes.

The zone of *Ammonites margaritatus* is exposed at Toad's Cove, Down Cliffs, near Bridport Harbour, Dorset; its position is shown in the section, p. 77, where the rock-bed contains *Ammonites margaritatus* and many of the same species of Conchifera found associated with that Ammonite, in other Marlstone districts. The star-fish-bed, with *Ophioderma Egertoni*, Brod., and *Ammonites fimbriatus*, Sow., is seen beneath the rock-bed of the Marlstone series.

<sup>1</sup> 'Geology of Yorkshire,' p. 101.

<sup>2</sup> Ibid., p. 102.

## 12. THE ZONE OF AMMONITES SPINATUS.

*Synonyms.*—Upper portion of the “Marlstone” of English authors. “Marnes à Plicatules,” Marcou, ‘Jura Salinois,’ p. 51. “Amaltheenthone (pars. sup.),” Quenst. “Die Schichten des *Ammonites spinatus*,” Oppel, ‘Juraformation,’ p. 138. “Spinatus-bed,” Wright, ‘Quart. Journ. Geol. Soc.,’ vol. xiv, p. 25.

This zone is so closely united with the Marlstone that it appears to form its upper portion, lithologically it is a light-coloured friable bed, containing many large fossiliferous nodules. *Ammonites spinatus*, Brug., *Belemnites breviformis*, Ziet., *Lima Hermannii*, Voltz., *Terebratula punctata*, Sow., and *Spirifer rostratus*, Schloth., are the prevailing forms.—

In Down Cliff the spinatus bed lies immediately in contact with the indurated marl of the Upper Lias containing *Ammonites serpentinus*, Reinecke, and other Upper Lias forms (see p. 77).

## THE UPPER LIAS.

I include all the marly, argillaceous, and arenaceous deposits found between the Marlstone and Inferior Oolite in the Upper Lias, and group these beds into two stages, each of which contains a special fauna.

The lower zone is, in general, an argillaceous formation, with occasional and inconstant bands of calcareous nodules; the fossils of this division are nearly all specifically distinct from those of the Marlstone on which it rests. The Ammonites of the group CAPRICORNII are all absent from these beds; and in their stead have appeared great numbers of the groups FALCIFERI and PLANULATI. In England one of the most prevailing species of the latter is the *Ammonites communis*, Sow., from which I have derived the name of the stage.

The upper zone in England is essentially an arenaceous formation, and although it possesses some species in common with the zones of *Ammonites communis* below, and *Ammonites Murchisonæ* of the Inferior Oolite above, it nevertheless contains a fauna sufficiently numerous in special forms to justify its separation from the *Am. communis* stage. Most of the Ammonites of the upper zone belong to the group FALCIFERI; a few, however, are common to both, those of the group LINEATI found herein are special to this zone, one of the most characteristic of which is the *Ammonites Jurensis*, Ziet.

## 13. THE ZONE OF AMMONITES COMMUNIS.

*Synonymy*.—"Alum shale," Young and Bird, 'Geol. of York,' p. 133. "Upper Lias" of English authors. "Posidonien-Schiefer," Römer, 'Oolit. Geb.,' p. 5, 1836. "Lias-Schiefer," von Buch, 'Jura Deutsch., Berl. Akadem.,' 1837. "Posidonien-Schiefer," Quenst., 'Flötzgebirge,' p. 538. "9<sup>e</sup> Étage, Toarcien (pars infer.)," d'Orbigny, 'Cours. élément. de Paléontol.,' p. 463. "Die Schichten der *Posidonomya Bronni*," Oppel, 'Juraformation,' p. 197. "Communis-bed," Wright, 'Quart. Journ. Geol. Soc.,' vol. xiv, p. 25.

In Gloucestershire this zone consists of bluish clay containing occasional and irregular bands of nodular argillaceous limestone resembling "cement stones." In the escarpments of the Cotteswold Hills it attains in some places a thickness of from 100 to 200 feet, and is there interposed between the sands or rock-beds of the Inferior Oolite and Marlstone. The Upper Lias clay is generally concealed by débris from superior strata, and its position is therefore most readily ascertained by surface indications, such as springs and marshes. As this clay-bed forms a retentive stratum at the base of the superincumbent porous strata, the rain, which falls upon the table-land of the Cotteswold Hills, after saturating the Oolitic rocks and subjacent sands, bursts forth as springs along their slopes and escarpments, at the junction of these beds with the impervious clay. All the springs in this district arising from the drainage of the Inferior Oolite have their origin in this arrangement of the strata.

On the summits of Bredon, Alderton, Gretton, and Churchdown Hills, all outliers of the Cotteswolds, we find sections of the lower or basement beds of the Upper Lias; these consist in general of the following sub-divisions:

1st. Brown marly clays of variable thickness, according to the extent of denudation of the upper beds; they contain many of the fossils of our list.

2nd. A band of nodular argillaceous limestone from six to eight inches in thickness, called the "Fish bed," this stratum has yielded many interesting remains. I obtained from a nodule at Gretton, a large and nearly perfect specimen of *Pachycormus latirostris*, Ag. ? and from nodules at Alderton, Dumbleton, and Gretton, *Leptolepis concentricus*, Egert., *Tetragonolepis discus*, Egert., have been extracted. Wings and elytra of insects have likewise been found in nodules at Dumbleton and Gretton, of which the most remarkable is a fine Neuropterous wing belonging to *Libellula Brodiei*, Buck.

3rd. Is a thick bed of bluish mottled clay, several feet in thickness, and more or less laminated, at Alderton, where I have seen it once well exposed; it contained a great many small Gasteropoda, among them were *Cerithium*, *Rostellaria*, *Trochus*, and *Natica*; of Conchifera, I found *Arca*, *Leda*, and *Posidonomya*; of Echinodermata I observed *Acrosalenia crinifera*, Quenst., *Pseudodiadema Moorei*, Wr., *Ophioderma*, n. sp., and



fragments of *Pentacrinus*. The shells were compressed moulds, which looked beautiful when the clay was first split open, but as it dried, the fossils unfortunately broke into fragments.

4th. The *Leptæna* bed is composed of a brown friable marl, one to two inches thick; it contains many species of small Brachiopoda, belonging to the genera *Leptæna*, *Spirifera*, and *Terebratula*, and is separated from the upper beds of the Marlstone by—

5th. A thin band of blue and yellow clay, containing many *Ammonites falcifer*, Sow., *Belemnites acuaris*, Schloth., and Brachiopoda, as *Rhynchonella pygmaea*, Moore. This bed rests upon light-coloured marls of the Spinatus stage.

From a railway cutting near Stroud, I have obtained many fine specimens of *Ammonites serpentinus*, Rein., and during the execution of works for drainage, and the formation of a new road near Nailsworth, a good section of the Upper Lias was exposed; from the bands of limestone numerous fossils were obtained, as *Ammonites communis*, Sow., *A. bifrons*, Brug., *A. falcifer*, Sow., *A. heterophyllus*, Sow., *A. cornucopia*, Y. and B., *A. Lythensis*, Y. and B., *Belemnites compressus*, Voltz., *Nautilus latidorsatus*, d'Orbig., *Turbo capitaneus*, Münster., *Pleurotomaria sub-decorata*, Münster., *Astarte lurida*, Sow., *Posidonomya Bronni*, Voltz., *Nucula Hausmanni*, Roem., *Gresslya gregaria*, Roem., *Lima bellula*, Mor. and Lyc., *Lima gigantea*, Sow., *Tancredia læviuscula*, Lyc., and several undescribed forms.

The Upper Lias at Illminster, Somerset, has become famous for the large number of species it has yielded to the long, patient, and careful investigations of Mr. Charles Moore, late resident in that locality. The beds here consist<sup>1</sup> of—

1. Rubbly beds 6—10 feet, containing *Ammonites communis*, Sow., *A. falcifer*, Sow., *A. Raquinianus*, d'Orbig., *A. bifrons*, Brug., *A. radians*, Rein., *A. insignis*, Schübl.
2. Clay, 8 inches.
3. Yellow limestone, 3—4 inches.
4. Layers of clay, 18 inches, *Leptæna Pearcei*, Dav.
5. *Leptæna* bed, 1 inch, *Leptæna Moorei*, Dav., *L. Bouchardii*, Dav., *L. liasina*, Bouchard.
6. Marlstone, 2½ inches, resting on greenish sand, containing *Belemnites* 4 inches and Marlstone.

Mr. Moore's museum contains *Teleosaurus*, *Ichthyosaurus*, and other reptiles, a magnificent collection of fishes, representing many new species of *Pachycormus*, *Lepidotus*, and other Upper Lias forms, in the finest possible preservation, the dark, enamelled scales of the fish contrasting finely with the pale yellow rock in which they are entombed. It was here likewise that Mr. Moore first discovered the *Leptæna* bed which contained

<sup>1</sup> Davidson's 'Monograph on British Oolitic and Liassic Brachiopoda,' Palæontographical Society, part 3, p. 17.

so many interesting forms of small Brachiopoda belonging to the genera *Leptæna*, *Spirifera*, *Thecidium*, *Rhynchonella*, and *Terebratula*, together with a number of *Gastropoda* and *Conchifera*, amounting to upwards of 150 species in all. The *Leptæna* bed forms a remarkable stratum, as it was found by M. E. Deslongchamps to occupy the same stratigraphical position at May, Calvados, as it does in Somersetshire and Gloucestershire. The following note, January, 1862, from my friend Thomas Davidson, Esq., explains the discovery of the Lias *Leptænas*: "When at Boulogne, in 1847, M. Bouchard received a parcel of fossils from the Lias of Pic de St. Loup, among which were several specimens of a small *Leptæna*, and about the same time I received a small parcel from Mr. C. Moore, among which I recognised two or three species of Lias *Leptæna*, which M. Bouchard and myself described, for the first time, in the 'Annals and Mag. of Natural History' for October, 1847. The discovery of the Lias *Leptænas* is therefore due to M. Bouchard and Mr. Moore. It was my description and publication of these species which first directed public attention to the subject."

*List of Fossils from the Zone of Ammonites communis (Gloucestershire).*

REPTILIA.

Teleosaurus.		Plesiosaurus.
Ichthyosaurus.		Pterodactylus (coracoid of).

FISHES.

Pachycormus latirostris, <i>Ag.?</i>		Tetragonolepis discus, <i>Egert.</i>
Leptolepis concentricus, <i>Egert.</i>		Dapedius, sp.

CRUSTACEA.

Coleia, sp.

INSECTA.

Libellula Brodiei, <i>Buck.</i>		Agrion Buckmanni, <i>Brod.</i>
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CEPHALOPODA.

Belemnites tripartitus, <i>Sow.</i>		Ammonites annulatus, <i>Sow.</i>
— acuarius, <i>Schloth.</i>		— falcifer, <i>Sow.</i>
— compressus, <i>Voltz.</i>		— Lythensis, <i>Y. and B.</i>
Nautilus latidorsatus, <i>d'Orbig.</i>		— Raquinianus, <i>d'Orbig.</i>
Ammonites communis, <i>Sow.</i>		— cornucopia, <i>Y. and B.</i>
— serpentinus, <i>Reinecke.</i>		— heterophyllus, <i>Sow.</i>
— bifrons, <i>Brug.</i>		Belemnosepia (ink-bag and osselets).

GASTEROPODA.

Turbo capitaneus, <i>Münst.</i>		Pleurotomaria, subdecorata, <i>Münst.</i>
Trochus bisertus, <i>Phil.</i>		

CONCHIFERA.

<i>Astarte lurida</i> , <i>Sow.</i>	<i>Tancredia læviuscula</i> , <i>Lyc.</i>
<i>Posidonomya Bronni</i> , <i>Voltz.</i>	<i>Placunopsis sparsicostatus</i> , <i>Lyc.</i>
<i>Nucula Hausmanni</i> , <i>Roem.</i>	<i>Inoceramus dubius</i> , <i>Sow.</i>
— <i>ovum</i> , <i>Sow.</i>	<i>Monotis substriata</i> , <i>Goldf.</i>
<i>Gresslya gregaria</i> , <i>Roem.</i>	<i>Arca inæquivalvis</i> , <i>Goldf.</i>
<i>Lima bellula</i> , ? <i>Lyc.</i> and <i>Mor.</i>	<i>Cucullæa Münster</i> , <i>Ziet.</i>
— <i>gigantea</i> , ? <i>Sow.</i>	

BRACHIOPODA.

<i>Leptæna Moorei</i> , <i>Dav.</i>	<i>Spirifer Ilminsterensis</i> , <i>Dav.</i>
— <i>liasina</i> , <i>Bouch.</i>	— <i>Münsteri</i> , <i>Dav.</i>
— <i>granulosa</i> , <i>Dav.</i>	<i>Rhynchonella pygmæa</i> , <i>Mor.</i>
<i>Thecidium rusticum</i> , <i>Moore.</i>	<i>Terebratula globulina</i> , <i>Dav.</i>
— <i>Bouchardii</i> , <i>Dav.</i>	— <i>Lycetti</i> , <i>Dav.</i>
<i>Lingula Beanii</i> , <i>Phil.</i>	

ECHINODERMATA.

<i>Acrosalenia crinifera</i> , <i>Quenst.</i>	<i>Pentacrinus</i> .
<i>Pseudodiadema Moorei</i> , <i>Wright.</i>	

THE ZONE OF AMMONITES JURENSIS.

*Synonyms*.—"Lias Zeta," Quenstedt, 'Der Jura Uebersichtstafel,' p. 293. "Zone des *Amm. torulosus* und zone des *Amm. Jurensis*," Oppel, 'Juraformation,' p. 296. "Marnes d'Aresche, et Marnes de Pinperdu," Marcou, franc-comtois, les Roches, 'Du Jura,' p. 119, "9<sup>e</sup> étage Toarcien (pars. sup.)," d'Orbigny, 'Cours. élément. de Paléontologie,' p. 469 (sect. at Thouars *h* to *l*). "Sands of the Inferior Oolite," Smith, De la Beche, Conybeare, and other English authors. "Cephalopoda bed and Upper Lias Sands," Wright, 'Quart. Jour. Geol. Soc.,' vol. xii, p. 292, 1856. "Ammonite Sands," Hull, 'Mem. of the Geol. Surv. Country around Cheltenham,' p. 25, 1857. "Cynocephala stage," Lycett, 'Cotteswold Hills,' p. 16, 1857. "Jurensis bed," Wright, 'Quart. Jour. Geol. Soc.,' vol. xiv, p. 25, 1857.

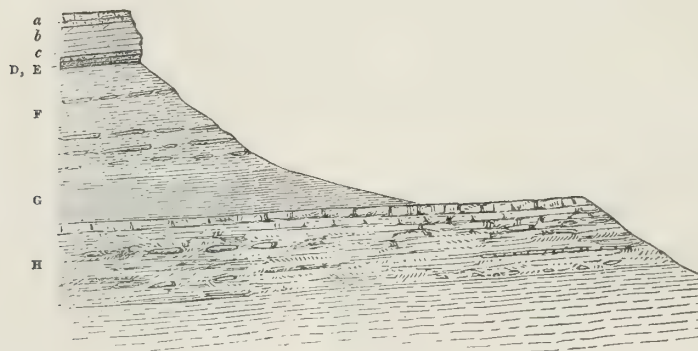
This youngest member of the great Lias formation has a limited geographical range ; for like other unconsolidated arenaceous deposits, it has been extensively affected by denudation. It is well developed in the counties of Gloucester, Somerset and Dorset, and at Blue Wick, on the Yorkshire coast. It may be advantageously studied at the latter locality, and in the fine section at Frocester Hill, and in other smaller exposures in the Nailsworth and Brimscombe Valleys in Gloucestershire. The following section of



Frocester Hill, near Stonehouse, affords the best type of the zone of *Ammonites Jurensis*.

*Section of Frocester Hill, near Stonehouse.*

FIG. 30.



*a, b, c.* Inferior Oolite; 70 feet.

*D, E.* Calcareo-ferruginous sandstone (Cephalopoda bed); 6 feet.

*F.* Yellow and brown sands, with inconstant and concretionary bands of calcareous sandstone; 150 feet?

} "Upper Lias Sands."  
Zone of *Ammonites Jurensis*.

*G.* Upper Lias shale; 80 feet = zone of *Ammonites communis*.

*H.* Marlstone; hard calcareous sandstone, resting on brown and gray sands, with bands and nodules of ferruginous sandstone; 150 feet = zone of *Ammonites margaritatus*.

*I.* Middle Lias shale = zone of *Ammonites capricornus*.

*Inferior Oolite.*

- |  | Ft.     | in. |
|--|---------|-----|
| <i>a.</i> A fine-grained oolitic limestone, similar to the freestones of Birdlip, Painswick, and Leckhampton Hills; the upper beds exhibit a most remarkable example of oblique bedding, the flaggy layers of which rest horizontally on inclined beds of freestone; thickness about .....   | 50      | 0   |
| <i>b.</i> A coarse, light, cream-coloured, gritty, cystalline Oolite, traversed at intervals by extremely crystalline shelly layers; a great part of the rock appears to be composed of fragments and plates of <i>Crinoideæ</i> plates and spines of <i>Echinidæ</i> , and comminuted fragments of the shells of <i>Mollusca</i> . This white rock has a most remarkable lithological character, and glistens brilliantly when lit up by the sun's rays. The shelly and pisolitic seams which traverse this bed resemble those in the Pea-grit. The surface of weathered slabs exposes numerous microscopic objects; the rock, in fact, is almost entirely composed of organic debris, and measures about ..... | 10      | 0   |
| <i>c.</i> A hard, fine-grained, oolitic, sandy limestone, of a light-brown colour, lithologically different from <i>b</i> . It contains many fossil shells, which are extracted with difficulty, and passes into a hard yellow Oolite with few fossils, attaining a thickness of from .....  | 8 to 10 | 0   |

[The lithological character of this rock is very different to that of *d*, on which it rests.]

*The Cephalopoda Bed—Upper Lias.*

ZONE OF AMMONITES JURENSIS.

	Ft.	in.
d. A coarse, dark-brown, calcareo-siliceous rock, full of small, dark, flattened grains of hydrate of iron. It contains an immense quantity of fossils, but <i>Ammonites</i> and <i>Belemnites</i> are the dominant forms; some of the bivalve shells are well preserved; the matrix adheres to the surface with such tenacity that they can seldom be cleaned without injury. The <i>Ammonites</i> and <i>Nautili</i> , for the most part, want the shell. <i>Rhynchonella cynocephala</i> lies in the upper part of the bed, and the <i>Ammonites</i> , <i>Belemnites</i> , <i>Nautili</i> , and other <i>Mollusca</i> in the middle part; the lower part is not so fossiliferous; this bed measures .....	4	6
e. A hard, coarse, brown mudstone, with hard irregular nodules of a calcareo-siliceous sandstone, highly micaceous and ferruginous, and passing downwards into the sands.	0	9
f. Fine, brown and yellowish, micaceous sands, passing into grayish coloured micaceous sands, with inconstant and concretionary bands of highly calcareous sandstone; nodules of various size occur in these bands, which are sometimes fossiliferous, containing chiefly <i>Ammonites</i> and <i>Belemnites</i> .....	150	!

ZONE OF AMMONITES COMMUNIS.

g. Blue clay and shale, marked by the outburst of springs and by pools of water on the terrace formed by the Upper Lias Clay .....	80	0
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ZONE OF AMMONITES MARGARITATUS.

h. Marlstone; a hard calcareous sandstone, resting on brown and gray sands, with bands and nodules of ferruginous sandstone .....	150	0
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ZONE OF AMMONITES CAPRICORNUS.

i. The shales of the Middle and Lower Lias, sloping down into the valley,		
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*Fossils of the Inferior Oolite.*

- a. Very few fossils in the Freestone; those observed were mostly fragmentary.
- b. The fossils in this bed are so much broken that I have not been able to determine them. Stems and column-plates of *Extracrinus*, portions of the tests of *Pygaster semi-sulcatus*, Phil., and *Acrosalenia Lycetti*, Wr., plates of *Cidaris*, and quantities of spines in fragments, are seen on the slabs.
- c. The following shells were observed, but could not be extracted from the upper part of the bed:
- |                           |                          |
|---------------------------|--------------------------|
| Pholadomya fidicula, Sow. | Trichites nodosus, Lyc.  |
| Modiola plicata, Sow.     | Serpula socialis, Goldf. |

The frond of a Fern was found in this bed by the Rev. P. B. Brodie. The lower part of the rock resting on the Cephalopoda bed is sparingly fossiliferous.

In very few localities, where the sands are exposed along the escarpments of the Cotteswolds or in the beautiful valleys intersecting these hills, are they found to contain

organic remains; fossiliferous veins have however been found at Frocester, Brimscombe, Nailsworth, Uley Bury, North Nibley and Ozleworth, and doubtless might be discovered in many other localities in this neighbourhood were the strata exposed.

The fossiliferous vein at Nailsworth lies near the base of the sands 4 or 5 feet above the Upper Lias clay. The bed consists of a fine soft ferruginous marly sandstone, of a deep brown colour, containing much peroxide of iron, and many shells, mostly of the same species as those found in the Cephalopoda bed at Frocester. The difference between these two beds is important, and deserves to be noticed, as the Cephalopoda bed at Frocester overlies the sands, whilst the fossiliferous vein at Nailsworth is found at their base, clearly proving that the sands and Cephalopoda bed form only one stage.

*Fossils of the Zone of Ammonites Jurensis.*

REPTILIA.

Vertebræ of *Ichthyosaurus*.

PISCES.

Teeth of *Hybodus*.

CEPHALOPODA.

*Ammonites opalinus*, *Reinecke*.

- *Comensis*, *von Buch*.
- *insignis*, *Schübler*.
- *Aalensis*, *Ziet*.
- *hircinus*, *Schloth*.
- *Jurensis*, *Zieten*.
- *striatulus*, *Sow*.
- *complanatus*, *Brug*.
- *Thouarsensis*, *d'Orb*.
- *radians*, *Reinecke*.
- *striatulus*, *Sow*.
- *Moorei*, *Lycett*.
- *Boulbiensis*, *Y. and B*.
- *inornatus*, *Williamson*.
- *discoides*, *Zieten*.

*Ammonites Raquinianus*, *d'Orb*.

- *Levesquei*, *d'Orb*.
- *fimbriatus*, *Sow*.
- *Leckenbyi*, *Lyc*.
- *variabilis*, *d'Orb*., var. *Beanii*, *Simp*.
- *variabilis*, *d'Orb*., var. *dispansus*, *Lyc*.
- *obliquatus*, *Y. and B.*, the aged form of *variabilis*.

*Nautilus latidorsatus*, *d'Orb*.

*Belemnites compressus*, *Voltz*.

- *tripartitus*, *Schloth*.
- *irregularis*, *Schloth*.
- *Nodotianus*, *d'Orb*.

GASTEROPODA.

*Pleurotomaria subdecorata*, *d'Orb*.

*Chemnitzia lineata*, *Sow*.

\**Turbo capitaneus*, *Münst*.

*Trochus duplicatus*, *Sow*.

\**Natica adducta*, *Phil*.

— *Oppelensis*, *Lyc*.



CONCHIFERA.

* <i>Lima bellula</i> , var., <i>Lyc.</i> and <i>Mor.</i>	<i>Cucullæa olivæformis</i> , <i>Lyc.</i>
* <i>Modiola plicata</i> , <i>Sow.</i>	* <i>Lima electra</i> , <i>d' Orb.</i>
* <i>Perna rugosa</i> , <i>Münst.</i>	<i>Unicardium</i> , nov. sp.
* <i>Hinnites abjectus</i> , <i>Phil.</i>	<i>Tancredia</i> , nov. sp.
* <i>Pecten articulatus</i> , <i>Goldf.</i>	<i>Trigonia Ramsayii</i> , <i>Wright.</i>
* <i>Gresslya abducta</i> , <i>Phil.</i>	* — <i>striata</i> , <i>Sow.</i>
* — <i>conformis</i> , <i>Agass.</i>	* — <i>costata</i> , <i>Sow.</i>
<i>Myacites arenacea</i> , <i>Lyc.</i>	<i>Pecten textorius?</i> <i>Goldf.</i>
* <i>Homomya crassiuscula</i> , <i>Lyc.</i>	* <i>Pholadomya fidicula</i> , <i>Sow.</i>
* <i>Goniomya angulifera</i> , <i>Sow.</i>	— <i>arenacea</i> , <i>Lyc.</i>
* <i>Myoconcha crassa</i> , <i>Sow.</i>	<i>Lima ornata</i> , <i>Lys. MS.</i> , nov. sp.
* <i>Cypricardia cordiformis</i> , <i>Desh.</i>	<i>Astarte lurida</i> , <i>Sow.</i>
* <i>Pecten comatus</i> , <i>Goldf.</i>	* — <i>excavata</i> , <i>Sow.</i>
<i>Opis carinatus</i> , <i>Wright.</i>	— <i>detrita</i> , <i>Goldf.</i>
* — <i>lunulatus</i> , <i>Sow.</i>	— <i>complanata</i> , <i>Roemer.</i>
<i>Cypricardia brevis</i> , <i>Wright.</i>	— <i>rugulosa</i> , <i>Lyc.</i>
<i>Cardium Hullii</i> , <i>Wright.</i>	<i>Gervillia fornicata</i> , <i>Lyc. MS.</i>
— <i>Oppelii</i> , <i>Wright.</i>	* — <i>Hartmanni</i> , <i>Goldf.</i>
<i>Cucullæa ferruginea</i> , <i>Lyc.</i>	<i>Nucula Jurensis</i> , <i>Quenst.</i>

BRACHIOPODA.

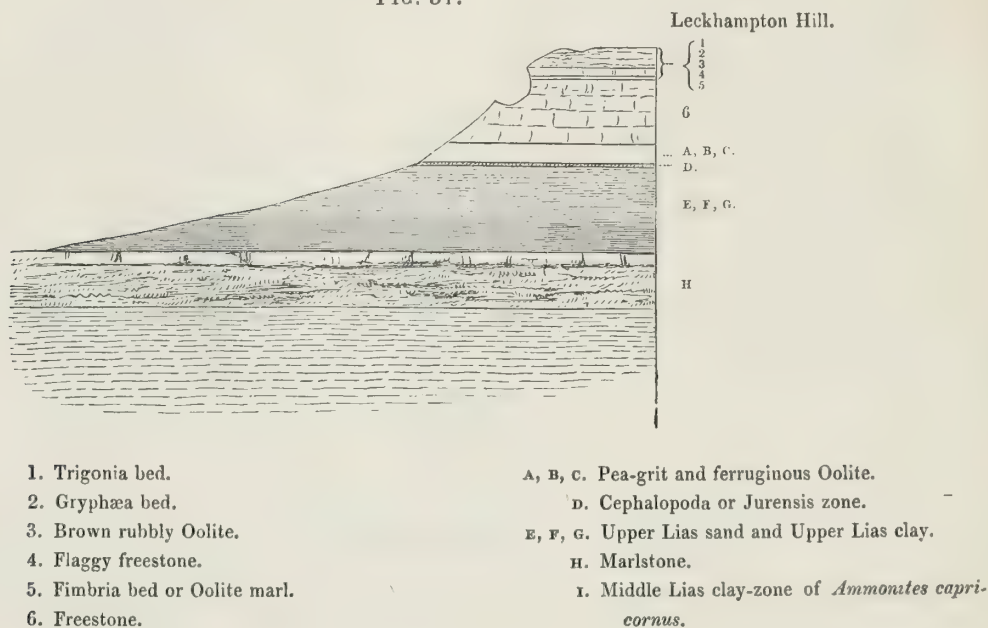
<i>Terebratula subpunctata</i> , <i>Dav.</i>	<i>Rhynchonella cynocephala</i> , <i>Rich.</i>
	— <i>Jurensis</i> , <i>Quenst.</i>

The species marked with an asterisk in the above list are found likewise in the Inferior Oolite; the specimens from the sands, however, are nearly all dwarfed forms, from which it is inferred that the physical conditions which then prevailed were unfavorable to their development. The stunted growth of the stationary *Conchifera* forms a striking contrast to the size, number and variety of the locomotive *Cephalopoda* interred with them in the same bed; in fact, the dawning existence of these *Conchifera* appears to have been a struggle for life, whilst the conditions under which the *Cephalopoda* existed were favorable to their continuance in time, as proved by the number of species and individuals of this class found in the Frocester beds; their life, notwithstanding, was abruptly brought to a termination by some great physical change which took place about the commencement of the deposition of the oolitic formations.

Leckhampton Hill, near Cheltenham, exhibits one of the most typical sections of the three sub-divisions of the Inferior Oolite, where the following beds are admirably exposed:—No. 1, 2 and 3 represent the zone of *Ammonites Parkinsoni*; No. 4 the zone of *Ammonites Humphriesianus*; No. 5, 6, and A, B, C, the zone of *Ammonites Murchisonæ*; these rest conformably on D, the Cephalopoda, or Jurensis bed, which is here very thin; E, F, G, is the Upper Lias resting on H, the Marlstone.

*Section of Leckhampton Hill, near Cheltenham.*

FIG. 31.



No. 1. The *Upper Trigonía bed* is a coarse brown ragstone, containing many fossils, chiefly as moulds and impressions of *Trigonía costata*, Sow., *T. decorata*, Lyc., *Lima cardiiformis*, Sow., *Rhynchonella concinna*, *Terebratula spinosa*, Schl., Sow., *Ammonites Parkinsoni*, Sow., *Echinobrissus clunicularis*, Lhywdd, *Holæctypus depressus*, Leske, and *Clypeus Plotii*, Klein; in thickness it is about seven feet.

No. 2. The *Gryphæa bed*, an ancient oyster bank, almost entirely composed of *Gryphæa sublobata*, Desh., with many other shells, as *Pholadomya Heraulti*, Ag., *Terebratula Meriani*, Opp., *Tancredia donaciformis*, Lyc., *Gervillia tortuosa*, Phil., and many other species; the dominant shell is the *Gryphæa*; this bed is about eight feet in thickness.

No. 3. The *Lower Trigonía bed*, a light-coloured, thin-bedded oolitic ragstone, containing a large assemblage of *Conchifera*, which in general have their shells preserved, with several species of *Echinodermata* and Corals.

No. 4. Upper flaggy bastard-freestone, well seen above the Oolite-marl: twenty-six

feet thick. It represents the zone of *Ammonites Humphriesianus*; this rock is here almost non-fossiliferous, although the equivalent bed at Cleeve Hill contains a rich fauna.

No. 5. The *Fimbria bed* or Oolite marl, is a cream-coloured mud-stone, not unlike chalk-marl; the dominant shell is *Terebratula fimbria*, Sow.; it contains likewise *Lucina Wrighti*, Oppel., *Lima punctata*, Phil., *L. Pontonis*, Lyc., *Natica Leckhamptonensis*, Lyc., *Natica adducta*, Phil., *Mytilus pectinatus*, Sow., *Astarte elegans*, Sow., *Nerinea*, sp., *Chemnitzia*, sp., and masses of Coral, chiefly *Thamnastræa Mettensis*, Edw. This bed was deposited under conditions very different to that of the freestone on which it rests; as its lower portion is slightly brecciated, and the surface of the freestone on which that breccia was deposited had been for some time exposed to aqueous action and made smooth thereby. The marl measures about seven feet in thickness, and passes upwards into a marly limestone, becoming oolitic in the uppermost layers. This division of the bed is about ten feet thick. The *Fimbria bed* is a constant feature in the Inferior Oolite of the Cheltenham district, and in the northern and middle Cotteswolds, but is absent in the southern parts of that range. It forms the upper part of the zone of *Ammonites Murchisonæ*.

No. 6. The *Freestone* is a compact light-coloured oolitic limestone; the uppermost beds are the best for building purposes; the middle beds are of an inferior quality, and are stained in part with the peroxide of iron; the lower beds contain large Oolite-grains, and are called "roestone;" the freestone in all is about 110 feet in thickness.

*The Pea-grit (Zone of Ammonites Murchisonæ) Inferior Oolite.*

	Ft.	in.
A. A brown, coarse, rubbly Oolite, full of flattened concretions cemented together by a calcareous matrix. When the blocks weather, the concretions, which resemble flattened peas, form a very uneven surface. It contains many fossils in good preservation ...	12	0
B. A hard, cream-coloured, pisolitic rock, made up of flattened concretions, with a thickness about similar to those in A.....	10	0
C. A coarse, brown, ferruginous rock, composed of large oolitic grains; it is readily disintegrated by the frost, and is of little economical value. About .....	20	0

*The Cephalopoda-bed (Zone of Ammonites Jurensis).*

D. A brown marly rock, full of small dark oolitic grains of the hydrate of iron, which are strewed in profusion in a calcareous paste. About .....	2	0
D'. A thin seam of yellowish sand .....	0	1½
E. A dark-gray crystalline limestone, extremely hard, and resembling some beds of the Carboniferous limestone; it is bored in different places by <i>Fistulana</i> ?, the shells of which remain in the excavations .....	0	9
F. A brown, argillaceous, sandy bed, full of micaceous particles; passing downwards into fine brown and yellow sands. Thickness unknown.		
G. Upper Lias Clay, of a dark blue colour. Thickness probably .....	160	0



*Fossils of the Pea-grit and Freestones.*

## CEPHALOPODA.

*Ammonites Murchisonæ*, Sow.  
*Nautilus truncatus*, Sow.

*Belemnites spinatus*, Quenst.

## GASTEROPODA.

*Patella rugosa*, Sow.  
 — *inornata*, Lyc.  
*Pileolus lævis*, Sow.  
*Nerita costata*, Sow.  
 — *minuta*, Sow.  
*Monodonta Lyelli*, d' Arch.  
 — *sulcosa*, d' Arch.  
*Natica adducta*, Phil.

*Cirrus nodosus*, Sow.  
*Trochotoma carinata*, Lyc.  
*Turbo capitaneus*, ? Goldf.  
*Trochus monilitectus*, Phil.  
*Solarium Cotswoldiæ*, Lyc.  
*Nerinæa cingenda*, Bronn.  
*Actæonina Sedgwicki*, Phil.

## CONCHIFERA.

*Ostrea costata*, Sow.  
*Placunopsis Jurensis*, Roem.  
*Hinnites velatus*, Goldf.  
*Limea duplicata*, Goldf.  
*Lima sulcata*, Münster.  
 — *lyrata*, Münster.  
 — *Lycetti*, Wright.  
 — *bellula*, Mor. and Lyc.  
*Pecten lens*, ? Sow.  
 — *Dewalquei*, Oppel.  
*Mytilus furcatus*, Münster.  
 — *striatulus*, Goldf.  
*Modiola Sowerbyana*, d' Orb.  
*Avicula complicata*, Buck.  
*Corbula involuta*, Goldf.  
*Tancredia axiniformis*, Phil.  
*Arca Prattii*, Mor. and Lyc.

*Arca pulchra*, Sow.  
 — *cancellata*, Phil.  
 — *lata*, Dunk.  
*Trigonia costata* (var. *pulla*), Sow.  
 — *exigua*, Lyc.  
*Astarte interlineata*, Lyc.  
 — *rhomboidalis*, Phil.  
*Sphæra Madridi*, d' Arch.  
*Cyprina trapeziformis*, Roem.  
*Unicardium*, nov. sp.  
*Myoconcha crassa*, Sow.  
*Ceromya Bajociana*, d' Orb.  
*Myopsis rotundata*, Buck.  
*Cardium striatulum*, Phil.  
 — *lævigatum*, Lyc.  
*Goniomya angulifera*, Sow.  
*Pinna cuneata*, Bean.

## BRACHIOPODA.

*Terebratula simplex*, Buck.  
 — *plicata*, Buck.  
 — *submaxillata*, Dav.  
*Rhynchonella Wrightii*, Dav.

*Rhynchonella decorata*, Dav.  
 — *angulata*, Sow.  
 — *oolitica*, Dav.  
 — nov. sp.

## ANNELIDA.

*Serpula grandis*, Goldf.  
 — *convoluta*, Goldf.  
 — *plicatilis*, Münster.

*Serpula quadrilatera*, Goldf.  
 — *flaccida*, Goldf.

ECHINODERMATA.

<i>Cidaris Fowleri</i> , <i>Wright</i> .	<i>Hemipedina tetragramma</i> , <i>Wr</i> .
— <i>Bouchardii</i> , <i>Wr</i> .	— <i>perforata</i> , <i>Wr</i> .
— <i>Wrightii</i> , <i>Desor</i> .	— <i>Bonei</i> , <i>Wr</i> .
<i>Rhabdocidaris Wrightii</i> , <i>Desor</i> .	<i>Pygaster semisulcatus</i> , <i>Phil</i> .
<i>Acrosalenia Lycetti</i> , <i>Wr</i> .	— <i>conoideus</i> , <i>Wr</i> .
<i>Pseudodiadema depressum</i> , <i>Ag</i> .	<i>Galeropygus agariciformis</i> , <i>Forb</i> .
<i>Stomechinus germinans</i> , <i>Phil</i> .	<i>Goniaster obtusus</i> , <i>Wr</i> .
<i>Polycyphus Deslongchampsii</i> , <i>Wr</i> .	<i>Pentacrinus</i> , nov. sp.
<i>Pedina Bakeri</i> , <i>Wr</i> .	

ANTHOZOA.

<i>Montlivaltia Delabecheii</i> , <i>Edw.</i> and <i>Haime</i> .	<i>Isastræa tenuistriata</i> , <i>E.</i> and <i>H</i> .
— <i>Waterhousei</i> , <i>E.</i> and <i>H</i> .	— <i>limitata</i> , <i>E.</i> and <i>H</i> .
— <i>cupuliformis</i> , <i>E.</i> and <i>H</i> .	<i>Thamnastræa Mettensis</i> , <i>E.</i> and <i>H</i> .
<i>Axosmilia Wrightii</i> , <i>E.</i> and <i>H</i> .	— <i>Defranciana</i> , <i>E.</i> and <i>H</i> .
<i>Latomeandra Flemingii</i> , <i>E.</i> and <i>H</i> .	— <i>fungiformis</i> , <i>E.</i> and <i>H</i> .

POLYZOA.

<i>Stromatopora dichotomoides</i> , <i>d'Orb</i> .	<i>Lichenopora Phillipsii</i> , <i>Haime</i> .
<i>Diastopora Waltoni</i> , <i>Haime</i> .	<i>Neuropora damicornis</i> , <i>Lamour</i> .
— <i>Michelini</i> , <i>Blainville</i> .	<i>Heteropora conifera</i> , <i>Lamour</i> .
— <i>Mettensis</i> , <i>Haime</i> .	— <i>pustulosa</i> , <i>Michel</i> .
— <i>Wrightii</i> , <i>Haime</i> .	<i>Theonoe Bowerbankii</i> , <i>Haime</i> .
<i>Spiropora straminea</i> , <i>Phil</i> .	<i>Berenicea diluviana</i> , <i>Lamour</i> .





# FOSSIL ASTERIADÆ.

## DESCRIPTION OF THE LIASSIC AND OOLITIC SPECIES.

Genus—URASTER, *Agassiz*, 1835.

STELLONIA, *Nardo*, 1834.

URASTER, *Agassiz*, pars, 1835.

ASTERIAS, *Grey*, 1841.

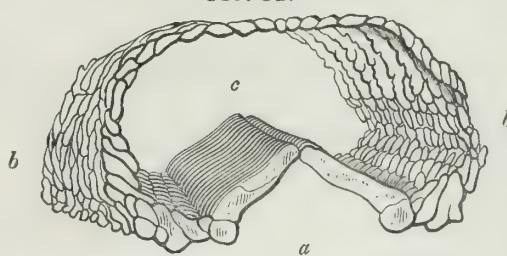
ASTERACANTHION, *Müller and Troschel*, 1840.

URASTER, *Forbes*, 1841.

Rays five, more or less cylindrical, and deeply cleft. The skeleton is composed of small, irregular-shaped ossicula, articulated together in a retiform manner, as seen in the subjoined section of a ray of *Uraster rubens*, Lin. (fig. 32) *a*, represents the long, femur-like, ambulacral ossicula; *b*, the small, short, interambulacral ossicles; and *c* is the cavity in the ray produced by this arrangement.

The whole of the upper surface of the disc and rays is studded with blunt or pointed spines, either scattered singly or grouped together in tufts, and, whether single or fasciculate, arranged more or less regularly in longitudinal rows (Pl. I, fig. 2, *a*). The integument between the spines is naked, and shows the base of the spines; in the interspinous portions of the integument are many respiratory pores (Pl. I, fig. 2, *a*, *b*). Numerous pincers-like pedicellariæ, supported on soft stems are scattered among the spines or arranged in circles around their bases.

FIG. 32.



Section of a ray of *Uraster rubens* showing the arrangement of the calcareous ossicula.

The wide ambulacral avenues are composed of two rows of long, compressed, femur-shaped bones, through which four series of tentaculæ or sucking-feet protrude (Pl. I, fig. 2, *b*). The vent is small and subcentral. The madreporiform body is single. The *Urasters* are found in all seas, but they prevail most in those of the Arctic and Atlantic regions; whilst in warm climates they are limited in numbers. Their presence, therefore, in any rock affords imperfect evidence of the climatal conditions under which it was deposited. All the oolitic species have hitherto been found in the Lias.

A.—*Species from the Lias.*

URASTER GAVEYI, *Forbes*. Pl. I, fig. 1, *a*, *b*.

URASTER GAVEYI, *Forbes*. British Organic Remains, Memoirs of the Geological Survey, decade iii, plate ii, 1850.

— — *Forbes*, in Morris's Catalogue of British Fossils, 2d ed., p. 90, 1854.

— — *Wright*. Monograph of Brit. Oolitic Echinodermata, p. 428, 1855.

Rays five, moderately lanceolate; ambulacral areas wide and well exposed; ambulacral ossicles long, arcuate, and bi-carinate; sides and upper surface of the rays, closely covered, with short, tapering, thorn-like spines; the proportionate diameters of the disc to the rays is as one to six.

*Dimensions*.—Diameter of the disc, one inch and three twelfths; maximum breadth of a ray, eight twelfths of an inch; maximum breadth of an ambulacrum, five twelfths of an inch; length of a ray from the angle of junction with the disc, three inches and a half; length of an ambulacrum from its origin at the mouth, four inches.

*Description*.—The wonderful specimen figured in Plate I was obtained from the Middle Lias at Chipping Campden, in the Zone of *Ammonites capricornus*; the four rays which remain exhibit the anatomy of the skeleton in great perfection and disclose the close affinities it has with *Uraster rubens*, Lin., of our present seas, showing that this type of animal structure, at least, has undergone little modification during the inconceivable period of time which has elapsed since the Lias formation was deposited. This Star-fish lies on its upper surface, in a slab of Lias, among which are strewed in great abundance *Ammonites capricornus*, Schloth., *Unicardium cardiodes*, Phil., *Cardium truncatum*, Phil., *Cypricardia cucullata*, Goldf., and separate ossicles of *Pentacrinus robustus*, Wr. The under surface (fig. 1, *a*) is fully exposed, and small portions of the upper surface are likewise seen, which partly display the general character of the structure and clothing of the dorsal integument; the upper surface of the rays appears to have been covered with short, stout, tapering spines, set very closely together on that portion of the integument exposed on the

slab; among these are scattered smaller and more slender spines with traces of *pedicellariæ*; the wide ambulacral valleys are bordered by two marginal rows of thin plates, which lie obliquely on each other, with steep sides towards the valley, and having on their convex under surface four or five elevations with concave summits, to which the moveable marginal spines of the rays were articulated (fig. 1, *b*).

The wide ambulacral valleys are flattened, and of nearly the same breadth throughout, they taper a little towards the mouth and the end of the ray (fig. 1 *a*); the narrow depression down the centre indicates the suture by which the ambulacral ossicula were articulated along the mesial line of the ray; these bones (fig. 1, *b*) "are narrow and linear in shape, slightly bent, with the appearance of a very shallow sigmoid curve. This is caused by the curved keel which runs down each, grooved throughout two thirds of its length, but depressed and marked with two pit-like impressions in the neighbourhood of the ambulacral sulcus (fig. 1, *b*); the ends of the ossicula which go to form the sulcus are slightly denticulated. The curvature of the ossicula has reference to the disposition of the suckers, which in this genus are arranged in four series down each avenue. The perforations are slightly ovate in this species." Forbes. In figure 1, *b*, I have given an enlarged drawing of four of the ambulacral ossicula, and the corresponding bordering plate, with its mammillary articulating surfaces and spiny borders, for a comparison with the homologous parts of the ray in the living *Uraster rubens* (fig. 3).

*Affinities and differences.*—The structure of the ambulacral skeleton, which is so admirably preserved in this fossil, removes all doubt as to its true generic position and affinities. It approaches so much, in fact, the existing *Uraster rubens*, Lin., of our coasts, that it requires a careful comparison of its specific characters to determine the distinction which undoubtedly exists between this Star-fish of the Lias sea and that of our own time. It resembles in form *Uraster carinatus*, Wr., of the Marlstone of Yorkshire, but the prominent dorsal ridges in that species appear to be absent in *Uraster Gaveyi*.

*Locality and Stratigraphical position.*—This beautiful specimen was discovered by my friend, G. E. Gavey, Esq., F.G.S., in a slab of Middle Lias from Mickelton Tunnel, near Chipping Campden, Gloucestershire, on the Oxford, Worcester, and Wolverhampton Railway. The rock on which it lies belongs to the Zone of *Ammonites capricornus*; with it are associated the following species of Echinoderms: *Cidaris Edwardsii*, Wr.; *Hemipodina Bowerbankii*, Wr.; *Tropidaster pectinatus*, Forb.; *Palæocoma Gaveyi*, Wr.; and *Pentacrinus robustus*, Wr.

URASTER CARINATUS, *Wright*, n. sp. Pl. II, fig. 1.

Rays five, long, and moderately lanceolate; upper surface of the disc crowded with short, thick spines; upper surface of the rays provided with three prominent carinæ, each



formed of a series of stout conical spines, set closely together in rows, and inclined in an imbricated manner on each other. The middle ridge is the broadest and most prominent.

*Dimensions.*—Diameter of the disc, two inches and a quarter; length of the only complete ray, from the intermediate angle of bifurcation, four inches and three quarters.

*Affinities and differences.*—In its general outline this Star-fish resembles *Uraster Gaveyi*, as we at present only know the under surface of that form and the upper surface of *Uraster carinatus* it is impossible to make a critical comparison of these Middle Lias Asteriadæ.

*Locality and Stratigraphical Position.*—This Star-fish was collected from the Marlstone at Bowlby, near Staithes, Yorkshire, and is the only example at present known. It belongs to the rich collection of my friend, John Leckenby, Esq., F.G.S., of Scarborough.

*Genus*—TROPIDASTER,<sup>1</sup> *Forbes*, 1850.

Body stellate, five-rayed (a vent on the dorsal surface?); rays convex and carinated above, the carina composed of a double series of squamose plates; rest of the dorsal surface spinous; spines simple; ambulacra bordered by transverse plates, with spiniferous crests on their anterior margins; ambulacral ossicula rather broad, geniculated, pectinated at their inner extremities. (Suckers biserial.)

A.—*Species from the Lias.*

TROPIDASTER PECTINATUS, *Forbes*. Pl. III, figs. 1, 2, 3.

TROPIDASTER PECTINATUS, *Forbes*. Memoirs of the Geological Survey of Great Britain, Figures and descriptions of Organic Remains, Decade iii, pl. iii, 1850.

— — *Forbes*, in Morris's Catalogue of British Fossils, 2d ed., p. 90.  
— — *Wright*. British Association Reports, vol. for 1856, p. 402.

*Description.*—My esteemed colleague, the late Professor Edward Forbes, gave so excellent an account of this Star-fish that I shall quote his description of the same entire. The general aspect of this species, when seen from above, is that of a *Uraster*, whilst viewed

<sup>1</sup> Τρωπις, a keel, and αστηρ, a star.

from below it resembles an *Astropecten*. The rays are rather short, about equal in length to the breadth of the disc, ovato-triangular. The upper surface of the rays and disc is covered with short, obtuse, simple spines, which, on the sides of the rays, are ranged in oblique rows of about five or six in each row. Placed rather laterally on the disc, is seen, though obscurely, a madreporiform plate, and I think I can perceive indications of an anal pore. Down the centre of each ray runs a keel composed of two rows of squamous plates, somewhat quadrate in form, but produced at their anterior and inner angles (fig. 2 *a*). This kind of keel, or mid-rib, is not present in any star-fish, recent or fossil, with which I am acquainted, and resembles in form and structure the tiling of the crest of the roof of a house. It must be regarded as a peculiarity of generic value. The rays themselves appear to have been very flexible, and not much liable to injury. Their extremities are rather pointed. On the under surface their centres are occupied by rather broad, lanceolate, ambulacral grooves running from the mouth (fig. 2 *a*); that orifice is somewhat contracted by the encroachment of the large, twin, triangular plates (fig. 3), with punctated surfaces, which occupy the angles formed by the junction of the bases of the rays. The ambulacral ossicula (fig. 2 *c*) are oblong, rather broad, strongly geniculated in the centre at their anterior margins, and denticulated by about five crenations at the edge which borders the ambulacral sulcus. The margins of the under surfaces of the rays are bordered by transverse, oblong, rather narrow plates (fig. 2 *c*), each bearing a crest at its anterior border, indented by the sockets of eight or more rather short cylindrical spines, which have rugose surfaces (fig. 2 *e*). It is these crested marginal plates, with their rows of spines, which give the under surface of this star-fish so much the aspect of an *Astropecten*.

*Affinities and differences.*—The affinities of *Tropidaster* have been so fully pointed out in the preceding description that it seems unnecessary to enter into more details on this branch of the subject. Since the specimen originally described by Professor Forbes was found, much larger and finer examples were discovered by my friend, Mr. Gavey, in the same locality; the best of these fossils I have figured in Pl. III, fig. 3, which shows very distinctly the large, prominent, twin, triangular plates around the mouth.

*Locality and Stratigraphical Position.*—This remarkable Star-fish was discovered by G. E. Gavey, Esq., F.G.S., in the Middle Lias at Mickelton Tunnel, near Chipping Campden, Gloucestershire, where it was associated with *Cidaris Edwardsii*, Wr., *Uraster Gaveyi*, Forb., *Palæocoma Gaveyi*, Wr., and *Pentacrinus robustus*, Wr., together with a series of Mollusca, characteristic of the zone of *Ammonites capricornus*, as *Ammonites capricornus*, Schloth., *Ammonites Henleyi*, Sow., and the usual species of Conchifera found interred with these Cephalopods.

Genus—*SOLASTER*, *Forbes*.

*CROSSASTER*, *Müller and Troschel*.

Body stellate; disc large, rays short and numerous; upper surface of the disc and rays covered with fasciculated spines; tegumentary membrane between the fasciculi naked; ambulacral furrows narrow, with two rows of pores for the tubular feet; no pedicellariæ; vent central.

FIG. 33.



Portion of a ray of *Solaster papposa*, Linn. A, the under; B, the upper surface.

The genus *Solaster* is represented in our epoch by only six species, two of which, *Solaster papposa*, Linn., and *Solaster endeca*, Linn., live in European seas. The only fossil which has hitherto been referred to this genus is the magnificent specimen figured in Plate IV, which was found at Windrush Quarry, Gloucestershire, in a block of light-coloured Oolitic freestone belonging to the Great Oolite; this unique fossil was obtained from the workman who discovered it by the Earl of Ducie, to whose collection it belongs.

A.—*Species from the Great Oolite*.

*SOLASTER MORETONIS*, *Forbes*. Pl. IV, fig. 1, a, b, c, d, e.

*SOLASTER MORETONIS*, *Forbes*. Morris's Catalogue of British Fossils, p. 89, 2d ed., 1854.

— — *Forbes*. Memoirs of the Geological Survey, Organic Remains, Decade v, pl. i, 1856.

— — *Wright*. British Association Reports, vol. for 1856, p. 402.

Disc large; rays numerous, thirty-three in number, narrow, linear, equal lengthened, tapering to a fine point; ambulacral furrows wide and deep, the margins of the rays provided with several rows of fine, acicular, close-set spines.

*Dimensions*.—Diameter of the body, from ray point to ray point, five inches; diameter of the disc, one inch and four tenths of an inch; length of the rays, one inch and nine tenths of an inch; breadth of a ray at the widest part, four twelfths of an inch; average breadth of an ambulacrum, two twelfths of an inch.



*Description.*—This remarkable fossil Star-fish, as it lies on the slab, with its under side only exposed, has been likened to the head of a Crinoid, with outspread arms crushed flat, but the structure of the rays at a glance discloses its true characters. It was referred by Professor Forbes, who first described it, to the genus *Solaster*, as it has most affinities with that group; the concealment of the dorsal tegumentary skeleton, however, prevents us from ascertaining with certainty whether it possessed paxillæ similar to those in existing species, and on which one of the main characters of the genus depends. In its general outline, and in the proportionate size of the disc, and the number and linear form of the arms, it resembles *Heliaster helianthus*, Linn., a many rayed species from the Pacific coasts of South America. A closer examination, however, of the structure of the rays shows that it belongs to a family in which the suckers are biserial, whereas all the *Urasteriade* have four rows of holes for the passage of tubular feet. It differs from all the living *Solasters* in having a proportionately smaller disc and a greater number of linear rays.

The skeleton of the disc is well preserved, it consists of a number of stout, oblong, rounded ossicles united together at their extremities, and forming a retiform structure, having a number of stellate centres at the junction of the ossicula, which are crowded together and overlap each other at these points; (fig. 1 *c*) shows the reticular pattern of the ossicles of the disc magnified. The connecting ossicula only are seen, the spiniferous bones being concealed from view.

The skeleton of the rays has been so well described by my lamented colleague Professor Forbes, that I give the description in his own words. "The rays are very narrow and linear-shaped, their sides being parallel throughout the greater part of their length. At the point of junction of the base of each ray with that of the next, is a pair of erect, semi-circular, compressed, slightly sinuous, sharp-edged bones, the angle-ossicula (fig. 4 *d*), their inner edges, or those directed towards the mouth, approximate; their outer edges are divergent. Their upper edges spread outwards, but much less so than in the corresponding bones in the recent *Solaster papposa*, Linn.; and they are much more compressed and elevated. Along their outer margin are rows of slender spines which are admirably preserved in the specimen.

Each avenue is composed of two series of ambulacral ossicles, about sixty in a row, their inner edges being minutely crenulated and accurately meeting along the centro-sutural line (fig. 1 *b*). These ossicles are shaped something like a dice box, each divided into two more expanded portions and a central narrower part, (fig. 1 *b*). The inner portion is flattened or slightly excavated, and somewhat rhomboidal, the outer elevated into a ridge. The middle and more contracted portion is carinated obliquely, and on the inner (proximal) side has a triangular groove. A similar groove occurs on the outer (distal) side, placed nearer the middle than the former. The sides of the ossicles are widely excavated for the purpose of forming the ambulacral perforation through which the soft suckers or ambulacral feet passed. The inter-ambulacral ossicles are rather quadrate (fig. 1 *c*), and divided diagonally, though somewhat irregularly, and lobe-like, into two portions, of which the inner or inferior portion is elevated, and the outer depressed. These ossicles change

shape, and become narrower as they approach the buccal regions of the ventral disc. Their crests, or elevated portions, bear combs of long, slender, acicular spines, with bulbous bases; of these spines there are from four to six in each transverse row, (fig. 1 c) shows these quadrate spiniferous ossicula with their crests of comb-like spines magnified.

The arrangement of the dorsal surface of the rays is too obscure in the few portions of those organs that are reversed to enable one to make out their details with certainty; but I think I can perceive pretty clearly the paxillated character of the spines, and that these bodies, forming the radiated or brush-like crowns of the paxilla above described, are much shorter and stouter than the marginal spines.

*Affinities and differences.*—This fossil Starfish is quite unique; the organic characters of the skeleton so closely resemble those possessed by *Solaster papposa*, prepared expressly for the purpose of minute comparison, that I cannot doubt its being a true *Solaster*, the modifications in the form of the bones of the rays and in the number of these processes clearly prove, however, that it appertains to an extinct species, in which all the generic characters of the group are well preserved.

*Locality and Stratigraphical position.*—This Star-fish was discovered by the workmen at Windrush Quarry, Gloucestershire, in a block of oolitic freestone, belonging to the Great Oolite. It is now the property of the Earl of Ducie; the species was dedicated to his lordship by Professor Forbes, who first described it in the fifth decade of "British Organic Remains," published by the 'Geological Survey of Great Britain.'<sup>1</sup>

#### *Genus*—GONIASTER, *Agassiz*.

This genus, as established by Agassiz<sup>2</sup> in his Prodrôme, includes Star-fishes with a pentagonal body, having the margin bordered with a pair of large plates, which sometimes carry spines; the upper surface of the body is covered with small tetragonal, or polygonal ossicles fitted within the marginal framework, the suckers are biserial, and the vent opens near the centre of the dorsal surface.

Müller and Troschel<sup>3</sup> suppressed the genus *Goniaster*, and formed, instead, three genera, *Astrogonium*, *Goniodiscus*, *Stellaster*, whose diagnostic characters were chiefly obtained from the structure of the marginal plates, as the following definitions indicate.

1. *Astrogonium*.—The large marginal plates are smooth towards the centre, and the border is surrounded by a circle of granules.

<sup>1</sup> 'Memoirs of the Geol. Survey, British Organic Remains,' pl. v, p. 3.

<sup>2</sup> "Prodrôme d'une Monogr. des Radiaires Échinodermes," 'Mémoires de la Société des Sciences Naturelles de Neuchâtel,' tome i, p. 191.

<sup>3</sup> 'System der Asteriden,' p. 52—62.



2. *Goniodiscus*.—The marginal plates have the whole of their upper surface granulated.
3. *Stellaster*.—The marginal plates are all granulated, and the ventral plates carry a suspended spine, as seen in the annexed figure, 34, of the under surface of a ray of *Stellaster Childreni*.<sup>1</sup>

FIG. 34.

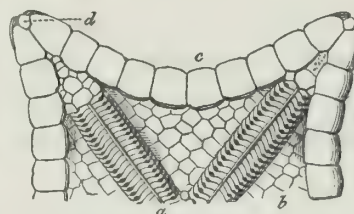
Under surface of a ray of *Stellaster Childreni*, Grey.

For our present purpose, I retain the genus *Goniaster* as originally defined, inasmuch as the oolitic species hitherto discovered have not retained those delicate characters on which the sub-genera of the ‘*System der Asteriden*’ were founded.

All the *Goniasters* have pentagonal bodies, with five angles, indicating the extremities of the rays, which in some species project more or less. The disc is always flat in dried specimens, or when removed from the water, but is capable of considerable elevation in their native element. They however always want the convexity of *Asteropsis* and the elevation of *Oreaster*. All the species have their margins bounded by two rows of large marginal plates (fig. 35 *c*), which enter into the formation of the sides of the disc and arms, and are always larger than the discal plates which occupy the upper and under surfaces of the body (fig. 35 *b*), and (fig. 36 *A* and *B*).

The size and characters of the marginal plates render them, in a palæontological point of view, the most important parts of the skeleton, as they are almost always well preserved, and afford, at the same time, characters which appear to be very constant in the different species. Their surface is either smooth or granulated, surrounded by granules or without decoration, some having spines or pedicellariæ, others being without such appendages. The marginal plates enter into the formation of the border and form a firm frame-work, into which all the other parts appear to be fitted (fig. 36). Among the living species, the character of the marginal plates and their appendages is apparently much more constant than among the fossil forms, and for this reason they have been used by zoologists for classificatory purposes.

FIG. 35.

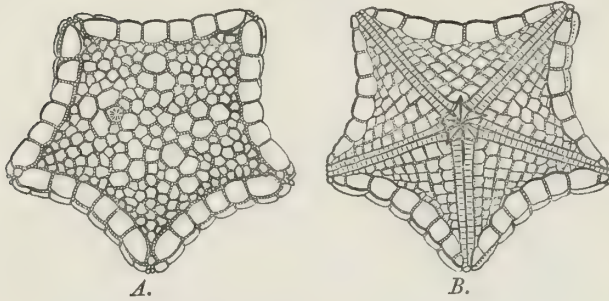
*Astrogonium cuspidatum*, M. and T.

<sup>1</sup> See p. 47, for further details of these genera.



The upper and under surfaces of the disc are covered with a kind of Mosaic composed

FIG. 36.



of small tetragonal or polygonal ossicles united by a delicate membrane; these plates are not firmly articulated together, and they are consequently easily displaced, so that they are rarely preserved in a fossil state. The ossicula of the disc and margin usually support small granular spines, and sometimes sessile pedicellariæ. The ambulacral furrows are

bordered by square ossicula, and the surfaces are marked by deep parallel grooves which serve for lodging the ambulacral spines (fig. 35 a). The marginal plates towards the termination of the rays are modified and enlarged for supporting and protecting the eyes (fig. 35 d).

A.—*Species from the Inferior Oolite.*

GONIASTER OBTUSUS, *Wright*. Pl. II, fig. 3 a, b, 3 c, 3 d.

GONIASTER OBTUSUS, *Wright*. British Association Reports, vol. for 1856, p. 402.

Rays elongated, rounded at the extremity; marginal plates convex and prominent, the upper row larger than the under, the entire surface of both plates covered with fine granulations; a single row of small polygonal plates between the upper marginals, the ocular plate at the end of the ray prominent.

The fragment above described is the largest portion of a *Goniaster* I have collected from the Pea Grit, Inferior Oolite. I have frequently obtained individual bones belonging to the marginal skeleton of this genus, but the conditions under which this deposit was accumulated appear to have been unfavorable for the conservation of the entire body. This fragment proves, however, that the GONIASTERIADÆ appeared with the dawn of the Jurassic epoch along with many new forms of Echinodermata in the seas that deposited the first oolitic sediments.

I found associated with this Star-fish *Cidaris Fowleri*, Wr., *C. Bouchardii*, Wr., *C. Wrightii*, Des., *Stomechinus germinans*, Phil., *Pseudodiadema depressum*, Ag., *Polycyphus Deslongchampsii*, Wr., *Pedina Bakeri*, Wr., *Hemipedina perforata*, Wr., together with *Galeropygus agariciformis*, Forb., and *Pygaster semisulcatus*, Phil., in considerable numbers.

B.—*Species from the Great Oolite.*

GONIASTER HAMPTONENSIS, *Wright*. Pl. II, fig. 2.

GONIASTER HAMPTONENSIS, *Wright*. British Association Reports, vol. for 1856, p. 402.

Body pentagonal, sides arched, rays projecting in the form of cones, and tapering to a point; marginal plates thick, sides elevated, and inclined inwards; upper surface of the disc covered with small polygonal ossicles.

*Dimensions*.—Diameter of the body from ray point to ray point, three inches; diameter of the disc, from the inner side of one superior marginal plate to the same point of the opposite margin, one inch and a quarter; depth of the border at the centre of the arched side, three-tenths of an inch.

*Description*.—The specimen figured in Pl. II, fig. 2, is the only *Goniaster* which has been found at Minchinhampton. It is unfortunately broken, and the portion preserved is so much incorporated with the matrix, that the sculpture on nearly all the marginal plates is destroyed. In the most perfect side, there are twenty-five upper marginal plates, but the lower series cannot be counted. The margin is high, and inclined inwards (fig. 2 *b*). The five rays project like narrow cones from the sides of the disc, thereby producing the arching of the margin so characteristic of this species (fig. 2 *a*).

The upper surface of the disc was covered with small tetragonal or polygonal plates, which have been so much effaced in carving out the fossil from the oolitic matrix, that sections only of a few of them remain. On one or two upper marginal plates, I have seen a finely granulated surface, whilst all the others are pitted by the oolitic grains during the process of crystallization in the replacement of the test.

*Affinities and differences*.—This oolitic species very much resembles some cretaceous forms, as *Goniaster Smithii* and *Goniaster Coombii*; the form and structure of the marginal plates, and the clothing of the upper disc appear very similar in both, there is no other oolitic species at present sufficiently known with which it can be compared; the mere fragment of *Goniaster obtusus*, Wr., from the Inferior Oolite, does not afford materials for comparison. The fine-pointed termination of the rays in *Goniaster Hamptonensis*, Wr., however, is very different from the blunted termination of the ray in *Goniaster obtusus*, Wr.

*Locality and Stratigraphical position*.—This specimen was discovered by Mr. Edward Day, many years ago, in the planking beds of the Great Oolite of Minchinhampton Common, by whom it was cleared or rather carved out of the soft freestone in which it was imbedded;

and sold by him to Professor Buckman, to whose collection it now belongs. In fig. 2 *a*, the fossil is represented lying on the under side, having the upper surface fully exposed; in fig. 2 *b*, a lateral view of the same is given, for the purpose of showing the height and inclination of the marginal plates; in neither figure has Mr. Bone ventured to delineate the ossicles of the disc.

FAMILY—ASTROPECTENIDÆ, *Müller and Troschel*.

The species of this family have a stellate body flattened on both sides. The rays are narrow, elongated, and bordered by one or two rows of marginal ossicula. The ventral plates are always spiniferous, and the dorsal, when present, are covered with granules which are more or less so likewise. The narrow ambulacral valleys, have two rows of holes for the passage of tubular feet. The upper surface of the body, between the marginal plates, is covered with paxillæ closely set together, and the under surface is crowded with short spines arranged in regular rows.

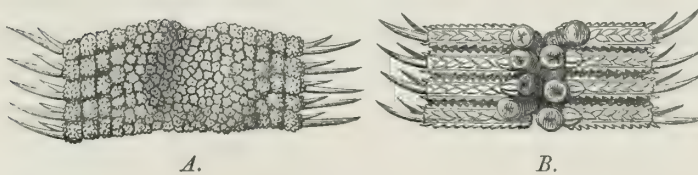
In the classification of Müller and Troschel this family comprises the genera *Astropecten* and *Ctenodiscus*, which possess a double series of marginal plates, and *Luidia*, with only a single ventral row of marginal spiniferous ossicula. At (page 48) the reader will find a diagnosis of the genera of this family; to these I have added the genus *Plumaster*, an extinct form from the Lias which has many affinities with *Luidia*.

Genus—LUIDIA, *Forbes*.

Rays elongated, and numerous. Margin provided with a single row of plates, instead of a double row as in *Astropecten*. These ventral marginal ossicula carry spines,

as seen in the subjoined figure of the section of a ray of *Luidia Senegalensis*, where *A* shows the upper, and *B* the lower surface. The upper surface of the body is covered with small close-set paxillæ (*A*). The ambulacral valleys are narrow, and the suckers biserial (*B*).

FIG. 37.



Portion of a ray of *Luidia Senegalensis*, M. and T. *A*, the upper;  
*B*, the under surface.

Two sets of spines are found on the underside of the ray, the central portion has rows of short, stout spines, and the marginal plates are armed with long recurved spines.



A.—*Species from the Lias.*

LUIDIA MURCHISONI, *Williamson*. Pl. V, fig. 2.

LUIDIA MURCHISONI, *Williamson*. Magazine of Nat. History, vol. ix, p. 425, 1836.

— MURCHISONI, *Forbes*. Mem. of the Geol. Surv., vol. ii, part 2, p. 480.

LUIDIA MURCHISONI, *Forbes*, in Morris's Catalogue of British Fossils, 2d ed., p. 83.

SOLASTER POLYNEMIA, *Simpson*. Fossils of the Yorkshire Lias, p. 135, 1855.

LUIDIA MURCHISONI, *Wright*. British Association Report, vol. for 1856, p. 402.

Rays twenty, moderate in length, obtuse at the apex, and having their margins fringed with numerous short, hair-like spines, mouth opening large, with impressions of radial processes.

*Description*.—This unique fossil Star-fish is so imperfectly preserved that only a few of its characters can be ascertained. It was first figured and described by Professor Williamson, in the ninth volume of Loudon's 'Magazine of Natural History' for 1836, and was thus described:

"This fossil was found in the marlstone at the point where it is carried up into the cliff to the north of the great fault, at the Peak Hill near Robin Hood's Bay, near the lower part of the stratum, where it blends with the lower lias. The slab on which the fossil is preserved is of a rather micaceous nature, a matrix, generally unfavorable for preserving minute characters; and a portion of the fossil having adhered to the upper part of the rock which fell in pieces, the view presented is rather that of the internal than the external structure of the animal. The central circle, the situation of the mouth, is preserved very distinctly, and proceeding with considerable regularity from this, is a series of rays, twenty in number. Those rays near their base bear the sulcus (furrow) which runs under those of recent Asteriæ; but towards their apex they become more worn and thin, showing in several places a small wiry line, with short ribs branching off at right angles, apparently a species of appendage, resembling what represents the vertebral column and ribs in the turtle, and which is observable in recent Asteriæ. There are also slight traces of transverse grooves on the whole surface of each ray; but these are generally almost obliterated. Along the margins are extremely regular rows of small rhomboidal perforations, or cells, from which proceed a series of lateral filaments, or delicate lengthened papillæ; but on the surface of the fossil, it merely presenting to us the interior, no papillæ are preserved. The apex of such rays as have not been broken off prior to the animal being entombed, are obtusely pointed."

*Locality and Stratigraphical position*.—From the appearance of the shale in which this specimen is embedded, it appears to come from the zone of *Ammonites capricornus*, it therefore belongs to the Middle Lias, and occupies about the same horizon as *Uraster Gaveyi*, Wr., from the Middle Lias of Gloucestershire.

Genus—PLUMASTER, *Wright*. 1861.

Rays numerous, long, and plume-like ; narrow at the base, expanded in the middle, and tapering gently towards an obtuse apex. The inter-ambulacral ossicula are much elongated transversely, they have a row of spiniferous tubercles on the middle of their under side, and their outer distal margin is pectinated fig. 1 *b*. ; the tubercles carry long hair-like spines, the ambulacral ossicula are thick and prominent, like the vertebral bones of *Ophiuriadæ* ; the avenues are narrow and depressed. The radial bones, at the base of the rays, form a conspicuous prominent ring around the mouth opening (fig. 1 *c*).

A.—*Species from the Lias.*

PLUMASTER OPHIUROIDES, *Wright*. Pl. V, figs. 1 *a*, 1 *b*.

Rays twelve, three times as long as the diameter of the disc, bent, and plume-like ; narrow at the base, expanded in the middle, with obtuse terminations ; ambulacra narrow and depressed, forming a furrow in the centre of the ray ; lateral ossicula long, bent, and slightly arched, with a row of tubercles on the centre of each bone. The proximal side of the ossicula, in relation to the disc, is slightly convex, and the distal side pectinated on its outer half, (fig. 1 *b*). The rows of tubercles support long spines which lie *in situ* in the specimen. The radial bones around the disc circle are very prominent, and resemble ancient trusses with a sculptured surface (fig. 1 *c*).

*Affinities and differences.*—This Star-fish resembles *Luidia* in the general form of the rays, whilst it differs from that genus in the structure of the lateral ossicles, and the possession of a conspicuous row of tubercles along the centre of each bone. It has some resemblance to *Pteraster*, but the fringe of marginal spines which forms so remarkable a character in *Pteraster* is wanting in *Plumaster*. These characters may be said to be generic, rather than specific, and as the specimen under consideration is a unicum, little more can be positively stated on the subject.

*Locality and Stratigraphical position.*—This beautiful Star-fish was found by Mr. Peter Cullen in the shales of the Middle Lias near Skinninggrave Bay, on the Yorkshire coast ; many of the rays are well preserved, the anatomical details however are partly concealed by an irremovable pyritic film. This unique specimen is the property of my friend, John Leckenby, Esq., F.G.S., and forms one of the many rarities contained in his rich cabinet of Yorkshire fossils.

Genus—ASTROPECTEN, *Linck.*, 1733.

STELLARIA, *Nardo*, 1834.

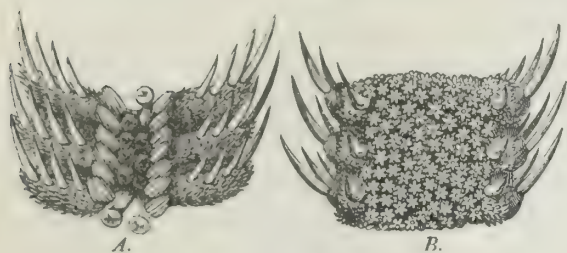
ASTERIAS, *Agassiz*, 1835.

— *Forbes*, 1841.

ASTROPECTEN, *Müller and Troschel*, 1842.

Body stellate, flat on both sides, rays elongated. Two rows of large marginal plates at the border. The lower series provided with spine-like scales, which increase in size from

FIG. 58.



Portion of a ray of *Astropecten polyacanthus*, M. and T. A, under surface; B, the upper surface of the ray.

within outwards, and terminate in long, moveable spines. The dorsal marginal plates are covered with granules, which often become spinous, and sometimes carry spines. The flat upper surface of the body and rays is thickly covered with appendages, the summits of which are crowned with groups of minute spines. This genus is the most abundant in the oolitic Rocks, the Lias, Inferior Oolite, Great Oolite, Kelloway Rock, Coral rag, Kimmeridge

clay, and Portland beds. All contain species characteristic of each of those divisions of the Jurassic series; the structural characters of these fossils are so admirably preserved in all our examples that we have no difficulty in referring them to the existing genus *Astropecten*.

A.—*Species from the Lias.*

ASTROPECTEN HASTINGLÆ, *Forbes*. Pl. VI, fig. 3 a, b, fig. 4 a, b.

ASTROPECTEN HASTINGLÆ, *Forbes*. Memoirs of the Geological Survey of Great Britain, vol. ii, part 2, p. 478, 1848.

— — — *Forbes*. Ibid., Brit. Organic Remains, decade 1st, pl. ii, fig. 1.

— — — *Wright*. British Association Reports, vol. for 1856, p. 402.

Rays five, short, acute, lanceolate, sides straight, intermediate angles obtuse; marginal plates quadrate, subequal; surface of the disc, on the upper and under sides, covered with small, tetragonal ossicles, arranged in a tessellated order.

*Dimensions*.—Diameter of the body from ray point to ray point, nearly two inches; diameter of the disc, one third of the whole.



*Description*.—Rays short in proportion to the rather broad, flat body, triangularly lanceolate, with very straight sides and pointed extremities. The angles formed by their junction with each other and the body are obtuse. Their margins are bordered by regular series of nearly equal square plates, decreasing but slightly as they approach the apex. The length of each ray is about equal to the diameter of the disc. There are about eighteen marginal plates in each row. The surface is covered by quadrate tessellations, indicating the arrangement of the plates, which probably, when the animal was alive, bore tufts of paxillæ or coronated spines. The specimen measures two inches in diameter.

*Affinities and differences*.—*Astropecten Phillipsii*, Forb., is probably its nearest fossil ally, but the form and characters of its surface distinguish it conspicuously from any other British member of its genus.

*Locality and Stratigraphical position*.—This species was discovered in the marlstone of Yorkshire; the original specimen, which I have not seen, nor can I discover in whose possession it now is, was figured and described by Professor Forbes from an example in the late Marchioness of Hastings' collection; I have therefore adopted entire my lamented colleague's description of this specimen. The other example (Pl. VI, fig. 4 *a, b*) I found on a slab of marlstone, from Boulby, near Staithes, associated with *Uraster carinatus*, Wr.; this specimen belongs to my friend, John Leckenby, Esq., F.G.S., and is now in his cabinet. Fig. 4 *a* shows the under surface of the Star-fish, and fig. 4 *b* the angular ossicles near the base of the rays; fig. 4 *b*, the ambulacral valleys, with the biserial tentacle pores and numerous quadrate plates, arranged in a tessellated manner.

#### B.—*Species from the Inferior Oolite.*

ASTROPECTEN LECKENBYI, *Wright*. Pl. VII, fig. 1 *a, b, c*.

Rays five, elongated, borders straight, intermediate angles very obtuse, border thick; marginal plates quadrate, elongated transversely, surface closely covered with large granules; madreporiform tubercle large, button-shaped, opposite one of the intermediate angles.

*Description*.—The border of this *Astropecten* is formed of thick marginal plates, of a quadrate form, the transverse diameter of which is twice as much as the length; their surface is covered with large granules, arranged in a quincuncial order, as shown in fig. 1 *c*. The rays are all more or less broken, consequently the entire number of marginal plates cannot be ascertained; in the most perfect ray remaining there are thirty-four plates. As the under surface of this Star-fish is immoveably fixed to the matrix, its upper

surface alone is exposed (fig. 1 *b*) ; the thickness of the marginal plates is well shown in section here. The remains of the large madreporiform body occupies an excentral position, on the upper surface, opposite one of the intermediate angles (fig. 1 *a*) ; as none of the structure of the intermarginal surface of the body is preserved, the character of the paxillæ is unknown.

*Locality and Stratigraphical position.*—This Star-fish was discovered in a boulder of Gray Limestone on the shore, by the White Nab, near Scarborough. The rock was described by Prof. Phillips as Great Oolite, but the zoological character of its fossils proves that the species are identical with the fauna from the zone of *Ammonites Humphriesianus* of the Inferior Oolite, to which I have referred the Gray Limestone in my memoir.<sup>1</sup>

*Astropecten Leckenbyi* was here associated with *Ammonites Humphriesianus*, Sow., *A. Blagdeni*, Sow., *A. Brackenbridgii*, Sow., and *A. Parkinsoni*, Sow., together with twenty species of Gasteropoda and forty species of Conchifera, all of which are, for the most part, characteristic of the Inferior Oolite. *Rhabdocidaris maxima*, *Pseudodiadema depressum*, Ag., *P. vagans*, Phil., *Astropecten Scarburgensis*, and *Ophiura Murravii*, Forb., are likewise found with it in the same bed of Gray Limestone.

This beautiful specimen is now preserved in the Scarborough Museum, and is the only example of the species that has yet been found.

ASTROPECTEN SCARBURGENSIS, *Wright*. Pl. VII, fig. 2 *a, b, c*.

Rays five, elongated, tapering to an acute point, intermediate angles acute ; border of the rays convex ; marginal plates thick, quadrate ; surface covered with small, close-set irregular granules.

*Dimensions.*—Transverse diameter from ray point to ray point, three and a half inches ; diameter of the disc across the marginal plates, one inch.

*Description.*—In many respects this species resembles *A. Leckenbyi*, but it differs from that form in having the intermediate angles more acute, the borders of the rays convex instead of straight, and the surface of the marginal plates covered with small irregular granules. As both these Star-fishes are unicum, I write with much reserve regarding their differences, knowing how often external characters are found to blend into each other when they are

<sup>1</sup> 'On the Subdivisions of the Inferior Oolite in the South of England,' and 'Quart. Jour. Geol. Soc.,' vol. xvi, p. 29.

examined and compared with the various modifications of form and structure which a number of specimens of the same species often exhibit after an attentive study thereof.

The rays in *Astropecten Scarburgensis* taper to an acute point (fig. 2 *a*), the borders are slightly convex, and there are about fifty ossicles around the margin of each ray; the ossicula are quadrate, much rounded, and have their surface covered with numerous small, close-set, granules (fig. 2 *c*); the ambulacral valleys are wide, and the ambulacral bones are elongated and quadrate (fig. 2 *b*); the upper and under marginal plates form well-marked prominences on the border, when examined in profile, as shown in this figure; a few small discal ossicles occupy the intermarginal spaces of the rays.

*Locality and Stratigraphical position.*—This specimen was discovered by Mr. Peter Cullen in the Gray Limestone near Scarborough. It belongs to the cabinet of my friend John Leckenby, Esq., F.G.S.

C.—*Species from the Stonesfield Slate.*

ASTROPECTEN COTTESWOLDIÆ, *Buck.* Pl. IX, fig. 3 *a, b, c*, fig. 4; Pl. X, fig. 1 *a, b, c, d*, and fig. 3 *a, b, c, d*.

ASTERIAS COTTESWOLDIÆ, *Buckman.* Murchison, Geol. of Cheltenham, 2nd ed., tab. iii, fig. 5, p. 94, 1845.

ASTROPECTEN COTTESWOLDIÆ, *Forbes.* Memoirs of the Geol. Survey, p. 479, 1848.

— — *Forbes.* Morris's Catalogue of British Fossils, 2nd ed., p. 72, 1854.

— — *Wright.* British Association Reports, vol. for 1856, p. 402.

Body flat, rays five, elongated, tapering to an acute point, border of the rays straight, intermediate angles obtuse; dorsal marginal plates quadrate, upper surface convex, and covered with small granules; ventral marginal plates spiniferous on their posterior borders; upper surface of the disc provided with five oblong, bilobed eminences, having two internal rows of serrated processes; a series of similar bilobed bones, diminishing in size towards the apex, occupy the middle of the rays, with which the discal eminences appear to be continuous; madreporiform tubercle large, excentral, with fine radiating lamellæ.

*Dimensions.*—Diameter of the body, from three to four inches; the proportionate diameter of the disc to that of the body is as one to three and a half.

*Description.*—This beautiful Star-fish is sometimes found in fine preservation on slabs of Stonesfield slate. The flat body is provided with five elongated rays, which gradually taper to an acute termination; the border of the ray is quite straight, and contains fifty-five



to sixty dorsal marginal plates, which have a quadrate form, being rather broader than long; they are well separated from each other, by reason of the convexity of their upper surface; the inner side of each ossicle is flat, the sides straight, and the outer margin and upper surface rounded, which imparts a moniliform character to the border of the ray; the convex surface of the ossicles is crowded with minute granules, most conspicuous near the vertex and disappearing on the sides.

The ventral border plates (Pl. X, fig. 1 *a, b, c, d*) have a rectilineal arrangement, and gradually diminish in size from the angle to the apex; on their posterior border is a row of three or four little tubercles, which support short, stout spines (Pl. X, fig. 1 *c* and *d*), and many of these are preserved *in situ*; in the only specimen in which I have seen the ventral surface exposed, these spines form a well-defined row, projecting outwards and backwards from the distal border of the ventral plates (Pl. X, fig. 1 *b, c, d*.)

The upper surface of the disc in the specimen figured in Pl. IX, fig. 1 *a*, exhibits five prominent, oblong bodies, bilobed in structure, and having on their inner surface a number of tooth-like processes, which mutually interlock. At fig. 1 *b* I have given an enlarged view of these bodies; they appear to be the upper portion of the large ambulacral bones, for we observe a series of similar bodies occupying the middle of the rays in other specimens where the matrix has been cleared away from these ossicles, as seen in each of the five rays of the specimens figured in Pl. IX, fig. 1 *a*, fig. 1 *c*; and in another specimen from the same locality (Pl. X, fig. 3 *b*, fig. 3 *d*) the ambulacral bones are well seen; the serrated line between the two halves of the oblong ossicles is the suture at the middle of the arch formed by the ambulacral bones; the position and relation of this median suture may be understood by referring to the section of a ray of *Uraster rubens* which I have given in fig. 32 *a*, page 99.

The madreporiform tubercle is moderately large, and situated near the border opposite one of the intermediate angles; it consists of numerous fine, vertical laminae, radiating from the centre, and which so closely resemble the septa of a *Montlivaltia* that the tubercle might readily be mistaken for a small fossil coral attached to the upper surface of the Star-fish.

The ventral surface (Pl. X, fig. 1 *a*) is shown in the only specimen I have seen with the under side exposed; the mouth-opening (fig. 1 *a*), is surrounded by five petals, each formed of two halves, and perforated in the middle for the passage of a tube, as shown in the enlarged drawing (fig. 1 *b*); at each intermediate angle there is an arch of small ossicles, two and three rows deep, arranged in an imbricated manner, and over the summit of each arch the point of one of the five petals rests; this arrangement produces a curious complicated structure, which is very well delineated in fig. 2 *b*; the surface of all the little ossicles entering into the formation of these arches is covered with small, spiniferous tubercles.

Within the ventral border plates are two rows of small, quadrate, spiniferous ossicles, forming the outer walls of the narrow ambulacral furrows, the inner border of these

ossicles supports numerous rows of small spines, as shown in fig. 1 *b*, and in the enlarged fig. 1 *c* the margin of the furrow is seen to have a comb-like structure where it closes over the ambulacral groove; the same figure shows likewise rows of stout, thorn-like spines projecting outwards from the ventral border plates.

*Affinities and differences.*—This Star-fish resembles very much *Astropecten Wittsii*, Wr., from the same beds; it has, however, a proportionately larger disc, more obtuse intermediate angles, and the rays more attenuated at their termination, as shown in the figures given of the two species in Pl. IX, figs. 1, 2, 3.

It has many points of affinity with *Astropecten Phillipsii*, Forb., but as I have not seen the original specimen of Prof. Phillips's drawing, I can offer no remarks on that form. Unless the actual specimens can be compared, figures scarcely afford data sufficiently accurate on minute points of structure, to justify critical observations on the affinities and differences existing between species nearly allied to each other.

*Locality and Stratigraphical position.*—This beautiful Star-fish was first discovered in Gloucestershire, by the Rev. E. F. Wits, in slabs of Stonesfield slate at Eyeford, near Naunton, and was figured by Prof. Buckman in the second edition of Sir R. Murchison's 'Geology of Cheltenham.' Good specimens, showing the marginal plates in relief, are rare, whilst sections of the skeleton are not uncommon in this fissile limestone, associated with the teeth of Fishes, the elytra of Insects, and the shells of Mollusca.

ASTROPECTEN COTTESWOLDIÆ, var. STAMFORDENSIS, Wright. Pl. VI, fig. 1 *a*, *b*.

Samuel Sharp, Esq., discovered a beautiful Star-fish in a slate bed near Stamford, which appears to be the equivalent of the Stonesfield slate. I have figured this specimen in Pl. VI, fig. 1, under the name *Astropecten Cotteswoldiæ*, var. *Stamfordensis*, Wr., as it presents some few traits of structure which distinguish it from the Eyeford specimens of the Cotteswold Hills. The upper marginal bones of the Stamford specimen are more angular, the intermediate angles more acute, and the borders of the rays straighter. As the specimen is a unicum, a critical comparison between forms so nearly allied is exceedingly difficult unless more of the anatomy of the Star-fish was exposed than happens to be in Mr. Sharp's specimen; I therefore prefer considering it provisionally as a variety of *Astropecten Cotteswoldiæ* rather than risk its separation on imperfect and it may be transient characters from that well-marked form already described in detail. I am indebted to Mr. Sharp for a description of the rock and locality where he found the specimen, and have much pleasure in adding his letter, of date 27th April, 1859, which he sent me in reply to inquiries made relative to the exact stratigraphical position of the bed from whence he obtained this Star-fish, and which leaves no doubt of its being true Stonesfield



slate, even if the lithological character of the matrix in which the fossil lies had not of itself been sufficiently characteristic of that formation.

“The Star-fish forwarded to Mr. Bone was found by me on the 13th of April, 1853, in the parish of St. Martin, in Stamford, which parish stands in Northamptonshire, separated from the other parts of the town by the river Welland, which at this point divides the counties of Northampton and Lincoln. There is a very curious fact in connection with the beds upon which Stamford and St. Martin’s stand. The valley of the Welland, which separates the old town from its outlying parish, narrows at this point almost to a gorge, and the ground rises steeply on either side. On the northern or Lincolnshire side the surface rises through and at the back of the town to an elevation of from 150 to 200 feet above the level of the river, and the strata of which this hill is composed consist of the Cornbrash; capping the higher elevation of the district is a thick bed of variegated and stratified clays equivalent to the Bradford clay. A series of beds of the Great Oolite, attaining a great thickness, and having as their lowest member a slaty bed occasionally very fossiliferous, and proved, I believe, to be equivalent to the Stonefield slate of Oxfordshire. Beneath these are the white, siliceous sand of the Inferior Oolite, and the Oolitic rock of the same formation, strongly impregnated with iron. Under all, and forming the basement bed of the district, lies the Lias clay, of unascertained thickness. The beds I have enumerated preserve, as nearly as may be, their horizontal position; they are intersected more or less by fissures, but otherwise exhibit little evidence of disturbance. Upon the Northamptonshire side, however, an upheaval has taken place, throwing up the lower beds to the top of the hill, and disturbing their horizontal position. The upper beds of the series are wanting on this side, but a huge fragment seems to have separated from the upheaved mass, and to have subsided into the chasm formed by the convulsion.

“Upon this fragment St. Martin stands; it is about three quarters of a mile in length, east and west, by about half a mile in width, north and south; its beds preserve nearly their original horizontal position, but they are divided near their western extremity by a fault running north and south.

“Thus, in proceeding from the river southward (up the hill), we have the Lias clay at the bottom, then the ironstone of the Inferior Oolite and its overlying sands, then the *slate bed*—Stonefield slate—and over this some of the very various beds of the Great Oolite. Still rising the hill, we come again to the Lias clay, the ironstone, the sands, slates, and Great Oolite, in a reiterated succession; but in this second series we have what we had not before observed, a bed of clay lying between the beds of the Great Oolite and the beds of the Inferior Oolite, and which clay, from its position, I suppose to be equivalent to the Fuller’s earth.

“It was in the *slate bed* of the *lower* series above described that I found the *Astropecten* in what is locally called a “pot-lid.” The lower beds of slates consist of masses of a flattened, semi-spherical form, lying with their convex surfaces downwards on the underlying bed of sand, in the hollows of which, it would seem as if they had been moulded.



"The exact geological position in which the specimen was found, is thus precisely fixed as at the base of the Great Oolite beds and the summit of the Inferior Oolite beds, in a stratum equivalent to and, in its general characteristics, I believe, identical with the *Stonesfield slate* of Oxfordshire."

ASTROPECTEN WITTSII, *Wright*. Pl. IX, fig. 2 *a*, *b*.

ASTROPECTEN WITTSII, *Wright*. British Association Reports, vol. for 1856, p. 402.

— — *Wright*. Monograph of Oolitic Echinodermata, p. 428, Pal. Soc., 1858.

Body flat; rays five, elongated, tapering to a blunt termination, border bulging at the middle of the ray, intermediate angles acute, disc small in proportion to the body; dorsal marginal plates quadrate, elongated transversely; upper surface of the disc and arms between the border plates, convex and prominent.

*Dimensions*.—Diameter of the body from ray point to ray point, two and a half inches; diameter of the disc from the outer side of one angle to the opposite, eleven twentieths of an inch, extreme breadth of a ray, three tenths of an inch.

*Description*.—This Star-fish resembles *Astropecten Cotteswoldiæ* in its general structure, but differs from it so much in the proportionate smallness of the disc to the diameter of the body and in the bulging of the rays that I have separated it from that more common form. It may probably be found to be a variety of *A. Cotteswoldiæ* should connecting links between the two forms hereafter be discovered; in the mean time, however, I have separated it from that species and dedicated it to my friend, the Rev. E. F. Wits, who first discovered Star-fishes in the Stonesfield slate of the Cotteswold Hills. The disc is small in proportion to the diameter of the body, in the ratio of one to five; the rays, five in number, are nearly of the same width throughout; the borders bulge slightly in the middle, and they terminate in blunted extremities; this is very apparent in the upper ray of fig. 2 *a*, but still more so in the specimen now before me. The marginal plates are quadrate, little elongated transversely; the surface is covered with fine granules, and there are about fifty plates around the border of the most perfect ray; the intermarginal space is convex and prominent, and the dorsal integument, with its numerous paxillæ, appears to be well preserved; in this specimen (fig. 2 *b*), the disc exhibits five elevations, corresponding to the inner ambulacral bones, within which it is slightly depressed. The remains of the madreporiform body, represented in the enlarged drawing (fig. 2 *b*), is seen close to the angle of the base of the longest ray; the intermediate angles are very acute, and the border plates compactly arranged, without the moniliform appearance seen in some allied species.

*Affinities and differences.*—This species very much resembles *Astropecten Cotteswoldiæ*, it differs from that form, however, in having the disc smaller in proportion to the diameter of the body, the rays a little swollen out in the middle, with their terminal extremities blunt and not attenuated, as in *Astropecten Cotteswoldiæ*; these characters may, perhaps, belong to varieties of that species, for the remark already made in reference to *A. Cotteswoldiæ* var. *Stamfordensis*, is applicable to this and other unicum, that were a number of different forms of the same species before us it is possible we might be able to link together differences by a series of gradations, without which the extreme varieties of typical forms might be considered characteristic of different species, for it is doubtless true that each species has its own limits of variation; in some these are circumscribed, in others they are enlarged, and it is by observation alone that the boundary between varieties and specific forms can be ascertained; hence the difficulty which surrounds the investigations of the palæontologist, for his materials are in general fragmentary, in many cases unique, and always requiring the most careful study, critical comparison, and accurate analysis; so that, without inclining to Darwinian notions on the one side or to modern species-making on the other, we feel the necessity of the greatest caution in pronouncing on specific differences between forms of which we only know solitary examples, and of these but partial details.

*Locality and Stratigraphical Position.*—This Starfish was collected from the Stonesfield slate of Eyeford, near Naunton, Gloucestershire, by the Rev. E. F. Wits, of Upper Slaughter, to whom I have dedicated the species, as an acknowledgment of his original discovery of *Astropecten Cotteswoldiæ* in the oolitic rocks of Gloucestershire.

ASTROPECTEN COTTESWOLDIÆ, var. STONESFIELDENSES. Pl. VIII, fig. 2.

Marginal plates thick and prominent, fifty around each ray, border straight, intermediate angles obtuse, inter-marginal spaces of the disc and rays covered with small ossicles; the plates have become so crystalline and weathered that all their delicate sculpture and other characters are effaced.

*Dimensions.*—Diameter of the body from ray point to ray point, four inches; diameter of the disc, one inch and one eighth.

This specimen belongs to the British Museum, it was bought at the sale of the late Mr. Johnson, of Bristol, and is supposed to be from the Stonesfield slate of Oxfordshire. It appears to be a large example of *Astropecten Cotteswoldiæ*, but the condition of the skeleton renders any minute examination thereof impossible.

D.—*Species from the Forest Marble.*

ASTROPECTEN PHILLIPSII, *Forbes*. Pl. X, fig. 2, *a, b, c, d, e.*

ASTROPECTEN PHILLIPSII, *Forbes*. Memoirs of the Geological Survey of Great Britain, vol. vi, part 2, p. 478, 1848.

— — *Forbes*. Ibid., British Organic Remains, decade 1st, pl. ii, fig. 2, 1849.

— — *Wright*. British Association Reports, vol. for 1856, p. 402.

Rays five, elongate, lanceolate; margins straight; intermediate angles obtuse; marginal plates quadrate, and transversely elongated, surface tuberculated, the tubercles supporting short, stout spines.

*Dimensions*.—Diameter of the body from ray point to ray point, about five inches; diameter of the disc, one inch and one sixth; breadth of a ray at the base six tenths of an inch. These measurements are only approximate, as the specimen is slightly distorted.

*Description*.—Disc moderately developed, the arms being in length, compared with its diameter, as one and three quarters to one.

Rays slender, lanceolate, forming very obtuse angles at the junction with each other and the body. Margins of the rays bordered with oblong quadrate plates, which are studded with small tubercles, probably marking the points of attachment of paxillæ; on their edges also are a few scattered linear-lanceolate spines, which are not equal to the breadth of the plate. The ambulacra are bordered with semicircular combs of short spines.

The plates composing the skeleton of the body appear to have been oblong. The marginal plates at the angles are narrow, as compared with those of the ray borders. The diameter of the body is about one inch and one sixth. The length of the rays appear to have been about two and one sixth inches; their breadth, near the junction of the rays with the body, is about seven twelfths.

*Affinities and differences*.—This beautiful species bears a striking resemblance to the recent *Astropecten arantiacus*, Lin., and its allies. No fossil species of this genus, as yet figured, so clearly proves the true generic position of the extinct forms as this.

*Locality and Stratigraphical Position*.—This lithograph was executed from a drawing by Prof. Phillips of a specimen obtained from the upper sandy beds of Forest Marble at Hinton-lane-end, Yorkshire; fig. 2 *a* shows the under surface; fig. 2 *b* the structure and



arrangement of the ambulacral bones; fig. 2 *c*, the surface of one of the marginal plates, magnified, with the small tubercles on its surface; fig. 2 *d*, the mode of articulation of the marginal plates with the row of stout spines arming their posterior border; fig. 2 *e*, one of these spines magnified, and showing its articulation to the tubercle.

ASTROPECTEN PHILLIPSII? Pl. X, *a*, fig. 2.

Rays five, short, tapering to an acute point; border thick and quite straight; intermediate angles obtuse; marginal plates moderately large, nearly quadrate, about fifty around the border of each ray; ventral plates only exposed, the outer border of each armed with short, stout, thorn-like spines; ventral portion of the disc wide; ambulacral furrows broad.

*Dimensions*.—Breadth of the disc, one inch and a quarter; diameter of the body, from ray point to ray point, three and a half inches; proportionate diameter of the disc to the length of a ray, one and a quarter to one and a half inches.

This Star-fish was figured in 'Loudon's Magazine of Natural History' for 1829, vol. ii, p. 73, and was thus noticed by a Yeovil correspondent, August 21st, 1828:—"I send you a drawing of the *Fossil Asteria* found at Horsington, by the Rev. James Hooper, Rector of Stawell. It was taken from a stratum of Cornbrash, and is a very perfect specimen. The sketch and the figure is of the exact size of the original." Being most anxious to obtain the original specimen, in order to give a better drawing of this beautiful Star-fish, with details of its structure, I commissioned a friend to make inquiries in the neighbourhood about the fossil, for since the discovery of the specimen Mr. Hooper had died, and his family had left. The collection, I learned, had been taken to Ireland, and I regret to add that I have been unable to trace the specimen. I am, therefore, under the necessity of reproducing the original figure from Loudon, more with the view of inducing geologists living near Yeovil to search the Cornbrash of that locality for other specimens of this Star-fish than for any scientific value in the figure itself. I have provisionally referred this species to *Astropecten Phillipsii*, as it resembles that form more than any other yet discovered.

ASTROPECTEN HUXLEYI, *Wright*, nov. sp. Pl. VIII, fig. 1 *a*, *b*, *c*, *d*.

Rays five, broad, gently bent, with sloping borders; intermediate angles obtuse; marginal plates quadrate, elongated transversely; surface covered with small, flattened tubercles, those on the ventral series supporting short, spatulate spines; several, longer, thorn-like spines project from their posterior border; ambulacral furrows wide; the small

inter-ambulacral bones at their border carry tufts of small, spatulate, equal-sized spines, which form a boundary for the ambulacral furrows; mouth surrounded by five ridge-like terminations; ventral integument covered with numerous rows of elongated, spatulate spines.

*Dimensions.*—Diameter of the ventral disc, one inch and eight tenths; length of a ray, about two inches and three tenths.

*Description.*—This Star-fish has all the five rays gently bent, indicating a flexible condition of the articulation of the marginal bones; this bending of the rays is well delineated in the drawing; the everted ray exhibiting the same curvature, which proves that the bending of the rays was dependent on the form of the articulating surfaces of the marginal bones, and not on muscular contraction, seeing that it was persistent after death.

The surface of the marginal plates, forty in number in the portion of the longest ray remaining (and probably the part which is absent had twenty more), is closely covered with small, flattened tubercles; those on the ventral plates support short, spatulate spines, which clothe the entire surface of the plates in an imbricated manner (fig. 1 *c*); the dorsal marginal plates are likewise covered with similar flattened tubercles, and many of the small spines which they supported are seen *in situ*; at the distal border of the ventral series several of the longer, thorn-like spines are seen which armed the border of the rays (fig. 1 *d*).

The everted ray exhibits in a very satisfactory manner the structure of its under surface; the ambulacral furrow is wide, and bounded by a series of small inter-ambulacral bones (fig. 1 *c*), which carry combs of small, flat spines, with flattened terminations on their lower edges. Fig. 1 *c* shows these tufts of spines hanging like festoons of fringes along the border of the ambulacral furrows (fig. 1 *b* and fig. 1 *c*). The inter-marginal tegumentary membrane of the disc and dorsal surface of the rays was strengthened with small ossicles, and the remains of the paxillæ are strewn abundantly amongst these calcareous pieces.

The tegumentary membrane on the ventral surface of the disc was covered with long, spatulate spines, which were disposed in rows in an imbricated manner; the under surface of the rays had likewise ranges of short, flat spines, set in rows on the marginal plates, and combs of spines on the inter-ambulacral bones, so that the under surface of this Star-fish was everywhere clothed with small, spatulate spines; the distal border of the ventral marginal plates had a row of larger, thorn-like spines projecting outwards.

The ventral surface of the disc is wide, and around its centre are five ridge-like bodies, with small tubercles on their surface (fig. 1 *a*); these bony processes might have been employed as jaws.

*Affinities and differences.*—This species is nearly allied to *Astrospecten Phillipsii*, Forb., but the greater size of the disc, with the breadth and curved shape of the rays, distinguish these forms from each other. The structure of the marginal plates and the inter-

ambulacral bones, with their combs of spatulate spines, afford additional evidence that these two Star-fishes appertain to distinct species.

*Locality and Stratigraphical Position.*—This Star-fish which belongs to the British Museum, was collected from the Forest Marble near Malmesbury, by Mr. William Buy, where it was associated with numerous Mollusca, Echinidæ, and Crinoidæ, appertaining to that formation.

I dedicate this species to my friend Professor Huxley, F.R.S., whose numerous contributions to palæontology and zoology have advanced the progress of these branches of natural science.

E.—*Species from the Kelloway Rock.*

ASTROPECTEN CLAVÆFORMIS, *Wright*. Pl. XI.

ASTERIAS ARENICOLA, *Charlesworth*. London Geol. Journ., tab. 17, 1847.

ASTROPECTEN ARENICOLUS, *Forbes*. Mem. of the Geol. Surv., vol. ii, part 2, p. 477, 1848.

— — — *Forbes*. In Morris's Catalogue of British Fossils, 2nd ed., p. 72, 1854.

— CLAVÆFORMIS, *Wright*. Mongr. of Oolitic Echinoderms, Pal. Soc., p. 428, 1860.

Rays five, convex, contracted at the base, enlarged at the inner third by the breadth of the marginal ossicula, and tapering gently throughout the two outer thirds of their length; disc small, its proportionate diameter to the body as 2 to 9; intermediate angles acute, and much contracted by the bulging of the rays; marginal plates variable in width, transversely elongated, and in general exceeding one third of the ray. Ambulacral furrows straight and linear, not participating in the enlargement of the margin, which is entirely owing to the form and development of the border plates.

*Dimensions.*—Diameter of the disc from one angle to another, one inch and eight tenths; diameter of the body, nine inches; width of a ray near the angle, one inch; width of a ray at the widest part of its enlargement, one inch and one fifth; from its maximum width to its worm-like point it gradually tapers.

*Description.*—This Star-fish was first figured in the 3rd part, pl. 17, of the 'London Geological Journal,' by Mr. Charlesworth, under the name of *Asterias arenicola*, Goldf., from the belief that it was identical with that species; in this opinion Professor Forbes<sup>1</sup> concurred, for we find in his memoir on 'British Fossil Asteriadæ' the following diagnosis of this form under the name *Astropecten arenicolus*, Goldfuss:

<sup>1</sup> Memoirs of the 'Geological Survey,' vol. ii, part 2, p. 477.



"*A. radiis* lanceolatis, longis, acuminatis, ad origines contractis; angulis intermediis acutis; *ossiculis marginalibus* angulorum brevibus, in parte latiori radiorum maximis, angusté oblongis, in apicibus radiorum quadratis.

"This species," he adds, "measures nearly a foot in diameter. The peculiar form of the rays, which, united by their bases at an acute angle (where the marginal plates are the narrowest), then swell out into a petaloid shape, and again contract into long, linear-lanceolate extremities, distinguishes it from all congeners. Each ray is to the diameter of the disc as three to one. There are about seventy plates on each side of each ray.

"Marlstone of Yorkshire. It was first described and figured from the Oolites of Germany."

A comparison of our figure with that of Goldfuss, shows that the German Star-fish although allied to, is specifically distinct from, our fossil; the disc is larger in proportion to the body, the area of the rays is likewise greater, and the marginal bones are wider, with a different order of increase; the intermediate angles are likewise more obtuse; there is no contraction at the base; the general form of the ray is entirely different, tapering to an obtuse termination, and having the marginal bones widest at the outer third of the ray; whereas in *Astropecten clavæformis*, Wr., the intermediate angles are very acute where the marginal plates are narrowest; they then suddenly swell out to their maximum breadth, and having attained that width, they gradually and regularly diminish, terminating in fine, worm-like extremities. These comparative differences clearly prove that *Astropecten clavæformis* constitutes a well-marked species, entirely distinct from *Astropecten arenicolus*, Goldf., with which it has hitherto been identified.

*Astropecten clavæformis*, Wr., is always found in the form of moulds, having the external figure of the body well preserved; many of these retain tolerably sharp impressions of the different external characters of the species; from one of these moulds, my friend, Mr. C. R. Bone, obtained a beautiful cast in gutta percha, showing the general contour of the body; aided by this and the impressions on the moulds, he has been enabled to produce the very truthful figure of this ancient Star-fish which he has given in Plate XI.

By the same process we have been enabled to figure, in Plate X A, fig. 3, a remarkable four-rayed variety of this species which I found in the Museum of the Yorkshire Philosophical Society. This specimen shows that the *Asteriadæ* of the oolitic fauna were liable to deformities of the same character as are found so frequently to prevail among their congeners of the present day.

*Affinities and differences.*—The nearest affinity of *Astropecten clavæformis* is with *Astropecten arenicolus*, Goldf.; the most obvious points of difference I have pointed out in the preceding paragraph. It is readily distinguished from *Astropecten rectus*, McCoy, in which the border of the rays is perfectly straight, without any enlargement near the base. Prof. Forbes described *Astropecten Orion* as a very regularly stellate species, having gradually tapering arms, bordered by square plates, which decrease regularly and gradually

towards the apices. This species was likewise extremely spiniferous, and possessed numerous rows of spines on the margin of the ambulacral avenues, which are absent in *Astropecten clavæformis*.

*Locality and Stratigraphical Position.*—Some strange blunders have been made about the rock in which this species is found. Prof. Forbes, in the memoir already quoted, calls it the Marlstone of Yorkshire, and Prof. Morris, in his 'Catalogue of British Fossils,' states it to come from the Lias of Yorkshire; local collectors nearly all refer it to the Calcareous Grit, and it is so catalogued in the York and other Museums. These, however, are mistakes, as the sandstone from which this Star-fish is obtained belongs to the Kelloway rock, which is well seen in position resting on the Cornbrash in a quarry near the Leavisham station on the Whitby branch of the North-Eastern Railway. The specimens are always in the form of moulds of the exterior, and in no instance has a fragment of any of the ossicula been discovered.

ASTROSPECTEN ORION, *Forbes*. Pl. X, fig. 1 a.

- |                     |                   |   |
|---------------------|-------------------|---|
| ASTROSPECTEN ORION, | <i>Forbes</i> .   | Memoirs of the Geol. Survey, vol. ii, part 2, p. 478, 1848.     |
| —                   | — <i>Forbes</i> . | In Morris's Catalogue of British Fossils, 2nd ed., p. 72, 1854. |
| —                   | — <i>Wright</i> . | British Association Reports, vol. for 1856, p. 402, 1856.       |
| —                   | — <i>Wright</i> . | British Oolitic Echinodermata, Palæont. Society, p. 428, 1860.  |

Rays five, linear, lanceolate, tapering to a blunt point; border straight, intermediate angles obtuse marginal plates small, quadrate, numerous, 55—60 around the border of a ray, each plate carries numerous small spines; disc moderately large; ambulacral valleys wide, bounded by one or more rows of short, stout, thickly set spines.

*Dimensions.*—Diameter of the disc, one inch and three quarters; length of a ray, three inches; length across the fossil, from ray point to ray point, six inches. This specimen is small and immature, and one ray is broken; a specimen, in the British Museum, measures eight inches across.

*Description.*—This Star-fish is found only as a mould in a sandstone bed of the Kelloway rock; most of the specimens, beyond the mere outline of the fossil, have few details preserved. In the museum of the Yorkshire Philosophical Society, however, I found a specimen in which the characters of the marginal plates and spines were well preserved; this the council of the society kindly communicated for this work. From this mould Mr. Bone obtained a very good cast in gutta percha, and from the relief and the specimen he has been able to produce, the excellent figure given in Pl. X A, fig. 1.



The marginal plates are small, square ossicles, which decrease in size gradually and regularly towards the apex of the rays; in the specimen figured, which is small, there are from 55—60 marginal plates around the border of the most perfect ray, and in larger specimens, where the number of the border plates increase with age, they may amount in a full-grown individual of this species to 80. These marginal plates are very spiniferous; in addition to the row of thorn-like spines at their distal border, the dorsal plates appear to have been clothed with small spines, from the numerous impressions they have left in the mould, and which are reproduced in the cast. The border is quite straight, and the rays taper gradually and regularly from the base to the apex.

The ambulacral valleys are wide and well defined; the small bones bounding these avenues supported one or more rows of short, stout spines, the numerous impressions of which are well preserved in the specimen and have been admirably reproduced in the cast.

As Prof. Forbes gave no figure of *Astropecten Orion*, nor marked by that name any specimen in the museum in Jermyn Street (then under his care), considerable doubt exists as to the Star-fish he had described as *A. Orion*. After the best consideration I have been able to give to the subject, I have come to the conclusion that the fossil I have figured must be the species intended. In the 'Memoirs of the Geological Survey' Prof. Forbes states that all the specimens of *A. Orion* are from the Oolites of Yorkshire, but in the list of Echinodermata published in Prof. Morris's 'Catalogue of British Fossils,' and supplied by Prof. Forbes, this species is said to have been obtained from the Lias of Yorkshire, and the same error is committed regarding *A. claviformis*, which is associated with *A. Orion* in the same formation; in fact, at the time my esteemed colleague published his notes on British Fossil Asteriadae, the true position of the sandstone containing these moulds of Star-fishes was not known, for by some the rock was called Calcareous Grit and by others Marlstone, whereas, in fact, it is a bed of the Kelloway rock. *Astropecten Orion* is thus described by Prof. Forbes:

"*A. radiis* lineari-lanceolatis, longis, lateribus rectis, angulis intermediis obtusis; *ossiculis marginalibus* omnibus (ossiculis angulorum exceptis) plus-minus ve quadratis spiniferis.

"Measures eight or more inches in diameter. A very regularly stellate species, having gradually tapering arms, bordered by square plates, which decrease regularly and gradually towards the apices. Each ray is to the diameter of the disc as three and a half to one. There are about forty ossicula on each side of each ray.

"In the collections of the Marchioness of Hastings, the Marquis of Northampton, and Dr. Bowerbank. All the specimens are from the Oolites of Yorkshire."

*Affinities and differences.*—This species resembles *Astropecten Phillipsii*, Forb., in its general outline and leading characters, but differs from that form in having the marginal



ossicles smaller, more numerous, and more spiniferous; the crowded rows of spines which bound the ambulacral valleys form a remarkable character in this Star-fish.

It differs from *Astropecten clavaformis*, Wr., associated with it in the same formation, in having the border straight, the marginal ossicles small, square, and spiniferous, and in having the rays lanceolate and tapering to a blunt apex. The swelling out of the ray towards the base, and the form and size of the marginal plates in that region, constitute diagnostic characters by which the two forms are readily distinguished from each other.

*Locality and Stratigraphical Position.*—All the specimens at present known have been obtained in the state of moulds from a bed of light-coloured sandstone appertaining to the Kelloway rock, near Leavisham station, on the Whitby branch of the North-Eastern Railway. In Newton Dale there is a fine development of the Middle Oolites, and most instructive sections of Kelloway rock, Oxford Clay, and Calcareous Grit are well exposed on each side of this railway which takes the line of the highly picturesque valley of the Esk.

The specimen I have figured belongs to the museum of the Yorkshire Philosophical Society. The British Museum, the Museum of Practical Geology, Jermyn Street, London, the Scarborough Museum, and the cabinets of Dr. Murray and John Leckenby, Esq., F.G.S., Scarborough, all contain fine specimens of this Star-fish.

F.—*Species from the Calcareous Grit.*

ASTROPECTEN RECTUS, *McCoy*. Pl. XII.

ASTROPECTEN RECTA, *McCoy*. Ann. and Mag. of Nat. Hist., 2nd series, vol. ii, p. 408, 1848.

— RECTUS, *Forbes*. Morris's Catalogue of British Fossils, 2nd ed., p. 73, 1854.

— — *Wright*. British Association Reports for 1856, p. 402, 1856.

— — *Wright*. Monograph of Oolitic Echinodermata, p. 428, 1858.

Rays five, narrow, elongated, tapering gradually from the angles to the apex, sides straight, bordered by two rows of quadrate marginal plates, averaging in width one third of the ray; surface covered with small tubercles and a row of larger, spiniferous tubercles on the distal border of each ossicle; intermediate angles acute; disc small in proportion to the body, proportionate diameter as two to nine.

*Dimensions.*—Diameter of the disc, one inch and nine tenths; breadth of the body from ray point to ray point, nine inches; length of a ray from the intermediate angle to the point, four inches and one quarter; breadth of a ray at the widest part, nine tenths of an inch.

*Description.*—This species is characterised by its long, linear, narrow, straight-sided rays, bordered by two rows of large marginal, quadrate ossicula, much lengthened transversely, each bone being about one third the length of the diameter of a ray; the whole of their convex upper surface is covered with small tubercles, as shown in our figure; at the posterior side of each bone is a row of three or four larger tubercles, which supported large spines; there are about ninety marginal bones around the border of a ray; along the inner side of the marginal plates a series of smaller quadrate ossicles is placed, three of these equalling the length of two of the marginal bones; the ambulacral ossicula are likewise covered with minute tubercles, and on the centre of each bone is one large tubercle for supporting a gigantic spine.

This Star-fish is for the most part known to us by horizontal sections of the skeleton as figured in Pl. XII. In one instance only have I seen the marginal bones free from the matrix, and these are figured in the same plate; this specimen which formerly belonged to the collection of Mr. Bean, of Scarborough, is now contained in the York Museum.

The diameter of the disc to that of the body is as two to nine, and many specimens attain a foot in diameter. The hard crystalline character of the Calcareous Grit in which this fossil is found conceals all details of the external structure of the ossicula beyond those I have figured.

*Affinities and differences.*—This species is well characterised by the narrowness and straightness of the rays and the large size of the marginal plates. It differs, therefore, from *Astropecten clavæformis* in the absence of the enlargement at the inner third of the rays which constitutes so remarkable a character of that form. Count Münster, in his 'Beiträge zur Petrefacten-Kunde' figured in pl. xi, fig. 1, of that work, a Star-fish under the name *Asterias Mandelslohi* obtained from the sandstone of the Inferior Oolite near Aalen, which has some resemblance to *Astropecten rectus*, but the marginal plates are proportionately narrower, and the ambulacral furrows considerably wider in the Aalen fossil than in our species.

*Locality and Stratigraphical Position.*—This species is obtained by splitting open the large nodules which fall out of the Calcareous Grit under Filey cliffs, near Filey Brig, on the Yorkshire coast. Mr. Peter Cullen informed me that all his specimens were obtained from this locality; they are, however, merely horizontal sections of the body and arms, for in only one specimen have I seen the form and surface of the marginal plates, I obtained a very large specimen of this species from the Calcareous Grit near Calne, in Wiltshire, which measures from the centre of the disc to the end of the ray six inches, giving the dimension of one foot to the body.





PLATE I.

URASTER GAVEYI, *Forbes*.

*From the Middle Lias.*

FIG.

1 *a.* URASTER GAVEYI, *Forb.*, p. 100. Under surface, natural size.

*b.* Plan of the ambulacral plates and their spiny borders.

2 *a.* Portion of the dorsal surface of a ray of *Uraster tenuispinus*, M. and T., to show the spines and pores in the tegumentary membrane.

*b.* Portion of the ventral surface of the same ray, to show the biserial arrangement of the tentacula in the ambulacral valley with the lateral spines bounding the same.

3. Diagram of the ambulacral plates in *Uraster rubens*, Lin., for the purpose of comparing them with the homologous parts in the Fossil species figured in the same plate.

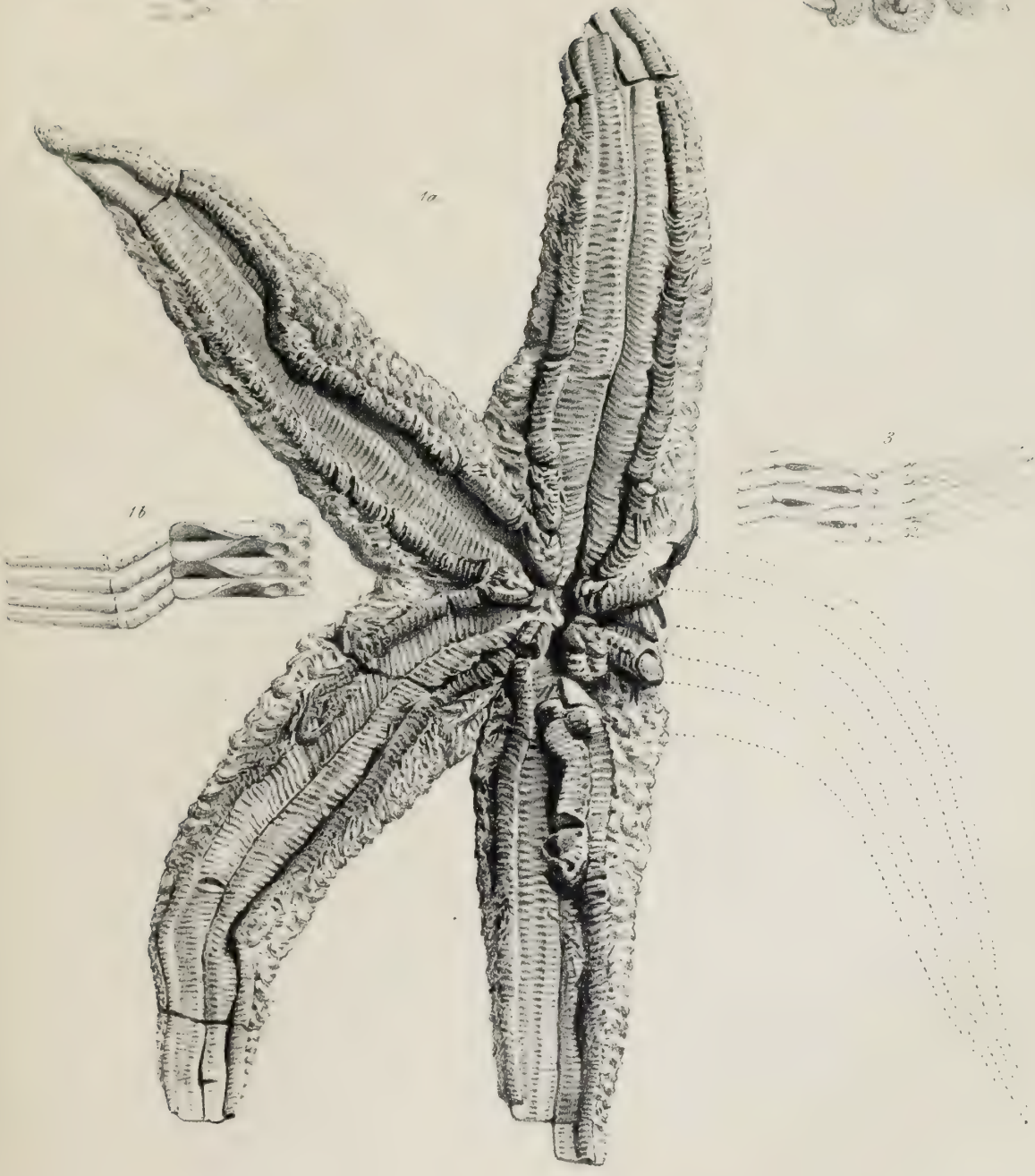
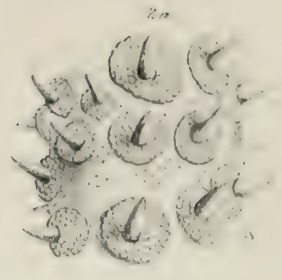
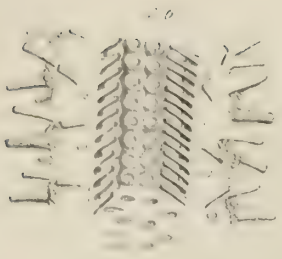








PLATE II.

URASTER CARINATUS, *Wright*.

*From the Marlstone.*

FIG.

1. URASTER CARINATUS, *Wright*, p. 101. Upper surface, natural size.

GONIASTER HAMPTONENSIS, *Wright*.

*From the Great Oolite.*

- 2 *a.* GONIASTER HAMPTONENSIS, *Wright*, p. 109. Upper surface, natural size.  
*b.* Lateral view of the same specimen, showing the dorsal and ventral marginal plates, natural size.

*From the Inferior Oolite.*

GONIASTER OBTUSUS, *Wright*.

- 3 *a.* GONIASTER OBTUSUS, *Wright*, p. 108. Upper surface of a ray, natural size.  
*b.* Under surface of the same ray.  
*c.* Lateral view of the same, both natural size.  
4 *a, b.* Marginal ossicles from an unknown Star-fish, magnified four times.  
5 *a, b.* Ditto ditto magnified four times.  
6 *a, b.* Ditto ditto magnified four times.

These ossicles were collected from the Bradford clay.

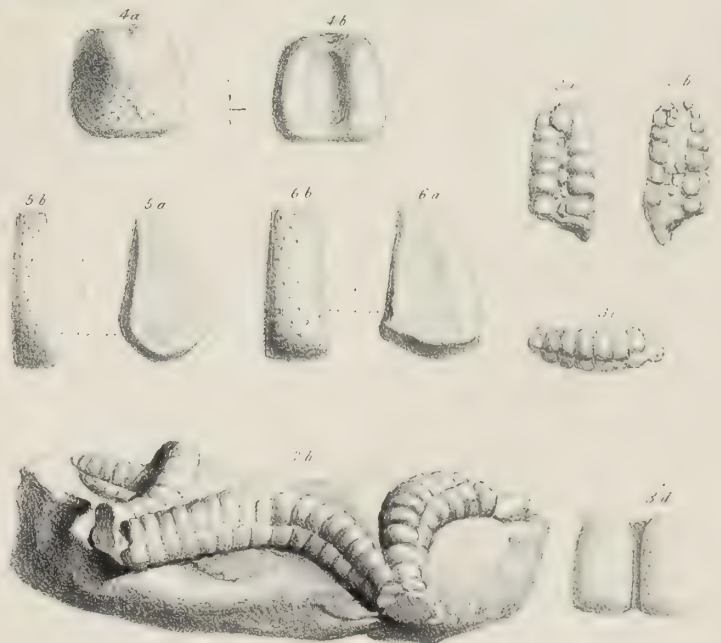
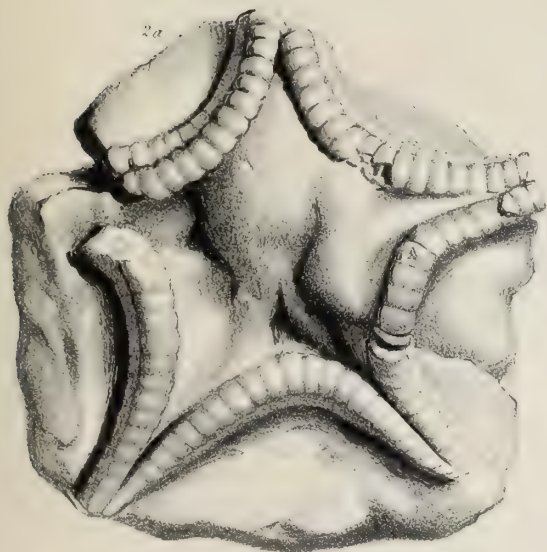
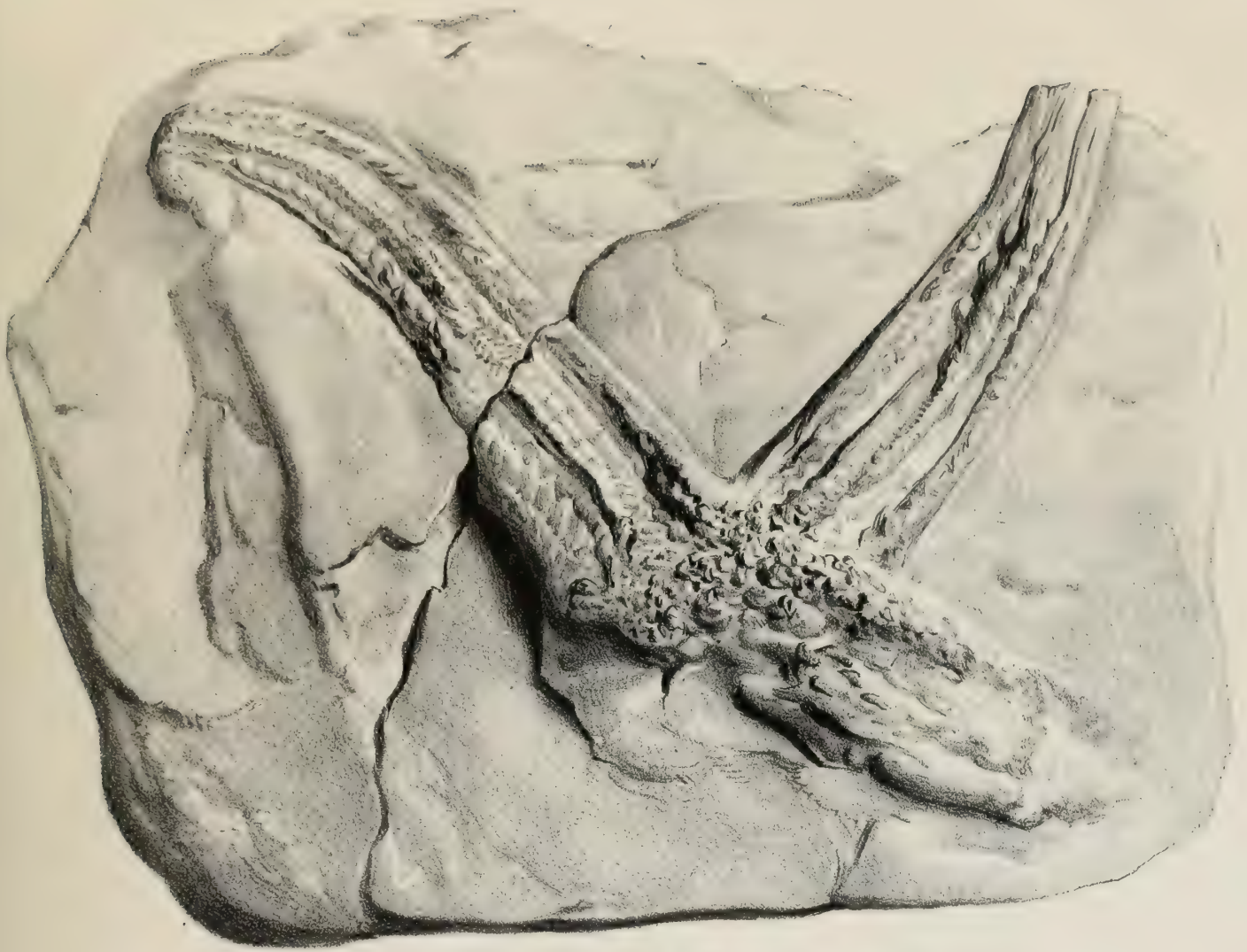








PLATE III.

TROPIDASTER PECTINATUS, *Forbes*.

*From the Middle Lias.*

FIG.

1. TROPIDASTER PECTINATUS, *Forb.*, p. 102. Showing the ventral surface, and a lateral view of the curved rays in small specimens.
2. Dorsal surface of two individuals on one slab, natural size.
  - a. Dorsal surface of a ray magnified, to show the arrangement of the middle ridge with its imbricated plates, and the tubercles on the inter-ambulacral portions.
  - b. Ventral surface of a ray, and part of the disc, showing the ambulacra and the angle-plates.
  - c. Ambulacral plates, and spiniferous plates bordering the ambulacral avenue, magnified.
  - d. Marginal plates, magnified.
  - f. Madreporiform body, magnified.
3. A large specimen with smaller attached, both natural size.



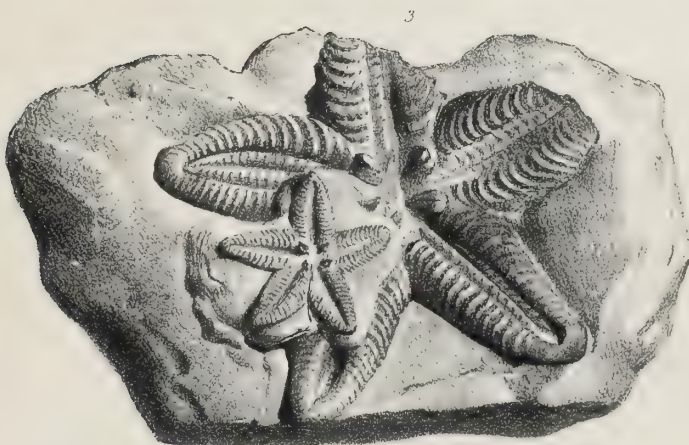
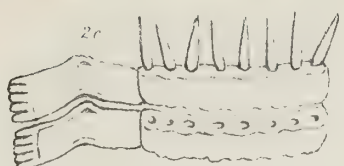
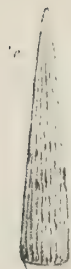
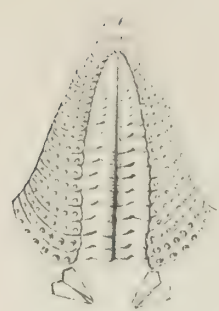








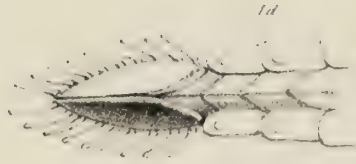
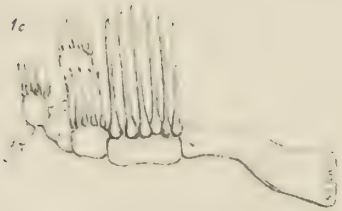
PLATE IV.

SOLASTER MORETONIS, *Forbes*.

*From the Great Oolite.*

FIG.

- 1 *a.* SOLASTER MORETONIS, *Forb.*, p. 104. Ventral surface, natural size.
- b.* Ambulacral ossicles, magnified.
- c.* An ambulacral bone, with inter-ambulacral ossicula supporting their combs of long hair-like spines, magnified.
- d.* Inner or proximal portion on an ambulacrum with its large angle ossicula and spines, magnified.
- e.* Retiform arrangement of the ossicula forming the framework of the disc, magnified.



1a

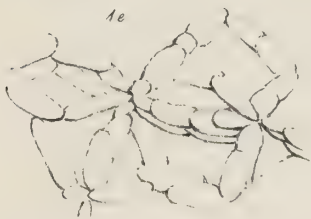
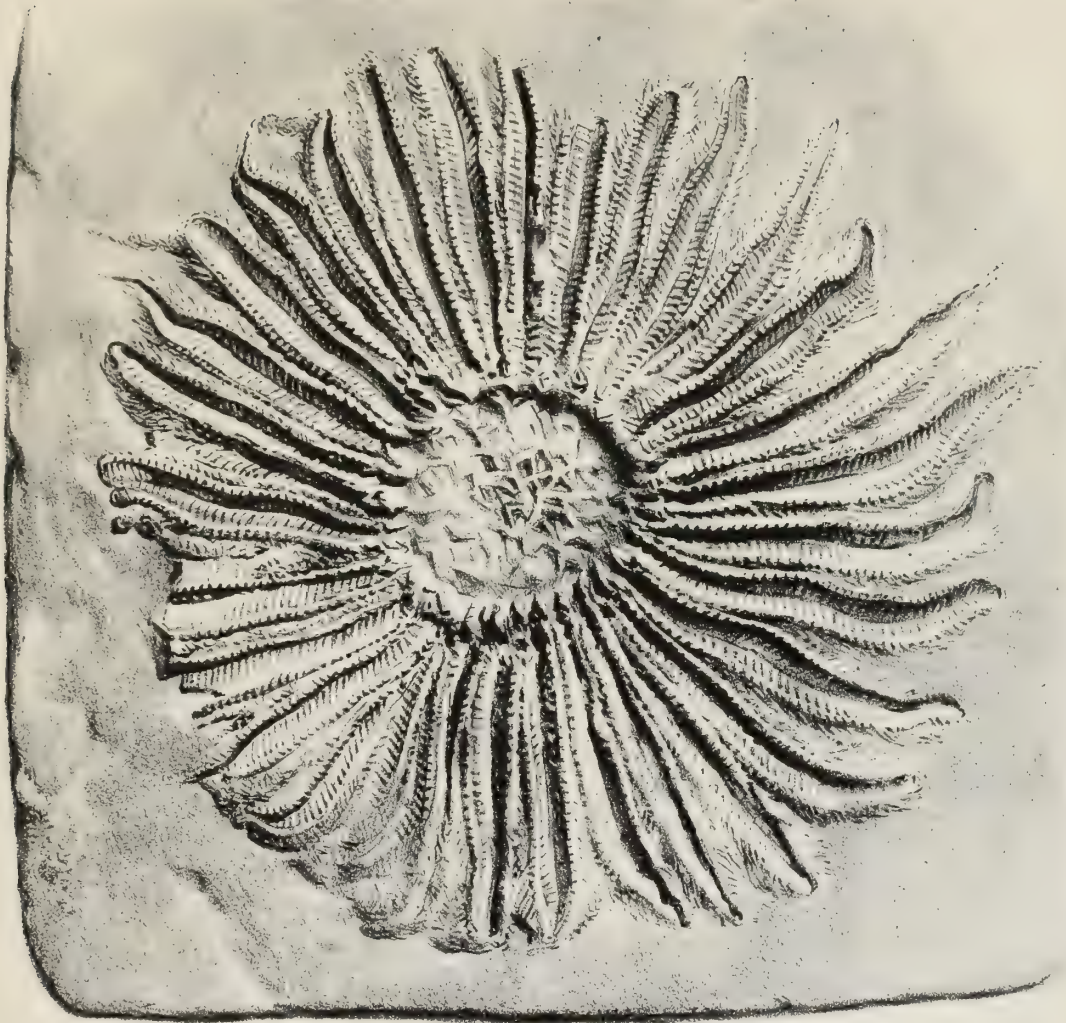








PLATE V.

PLUMASTER OPHIUROIDES, *Wright*.

*From the Middle Lias.*

FIG.

- 1 *a.* PLUMASTER OPHIUROIDES, *Wright*, p. 112. Ventral surface, natural size.
- b.* Ambulacral and inter-ambulacral ossicula, magnified; the long inter-ambulacral plates with pectinated distal borders supporting rows of spiniferous tubercles.
- c.* A pair of large angle-plates with tubercles on their surface, magnified.

LUIDIA MURCHISONI, *Williamson*.

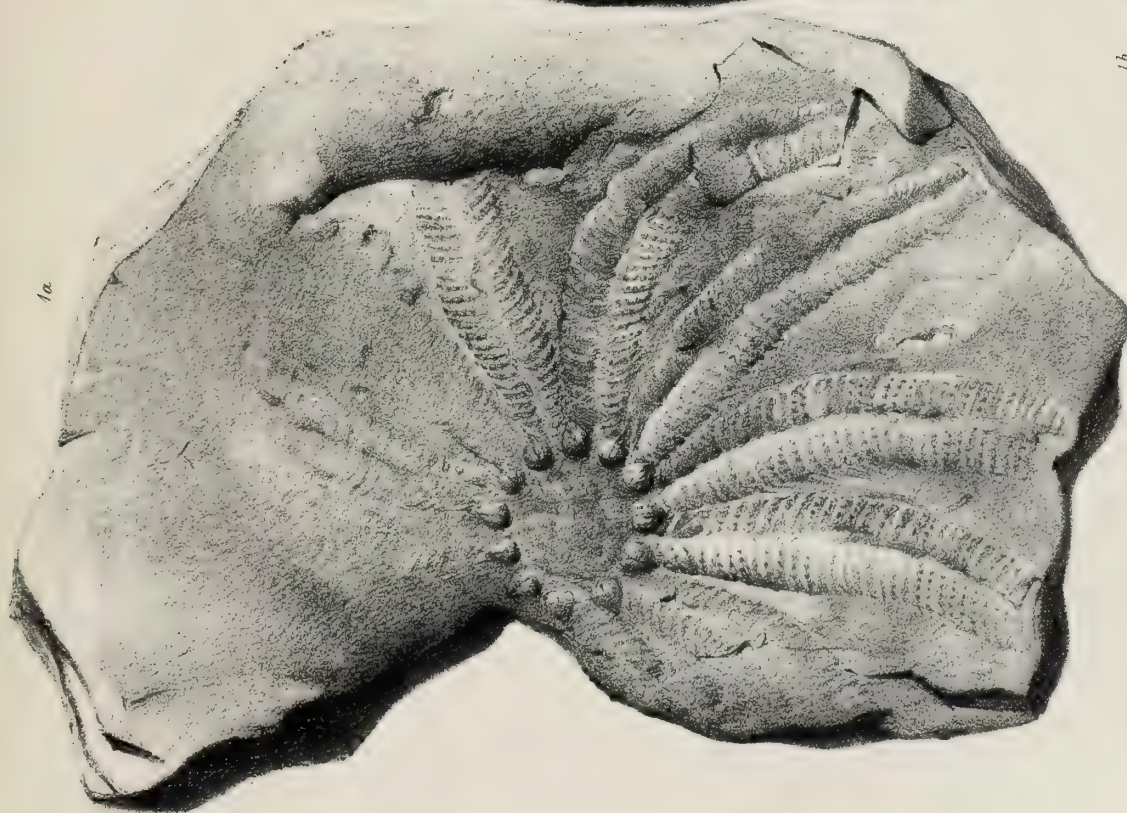
*From the Middle Lias.*

2. LUIDIA MURCHISONI, *Williamson*, p. 111. Ventral surface, natural size.

2



1a



1b



1c









PLATE VI.

ASTROPECTEN COTTESWOLDIÆ, var. STAMFORDENSIS, *Wright*.

*From the Stonesfield Slate.*

FIG.

- 1 *a.* ASTROPECTEN COTTESWOLDIÆ, var. STAMFORDENSIS, *Wright*, p. 118. Dorsal surface, natural size.  
*b.* Two marginal plates, with rows of spines at their distal border.
- 2 *a.* ASTROPECTEN COTTESWOLDIÆ, *Buck.*, p. 116. Small specimen, natural size.  
*b.* Four marginal plates of this specimen, showing the sculpture on their surface, the distal spines, and connecting ossicula, magnified.

ASTROPECTEN HASTINGIÆ, *Forbes*.

*From the Marlstone.*

- 3 *a.* ASTROPECTEN HASTINGIÆ, *Forb.*, p. 113. Dorsal surface, natural size.  
*b.* Marginal plates and inter-marginal ossicles of the same, magnified.
- 4 *a.* ASTROPECTEN HASTINGIÆ, *Forb.* Ventral surface of Mr. Leckenby's specimen, showing the ambulacral avenues, natural size.  
*b.* Angle-plates, ambulacral avenues, biserial pores, and inter-ambulacral plates of the same, magnified three diameters.



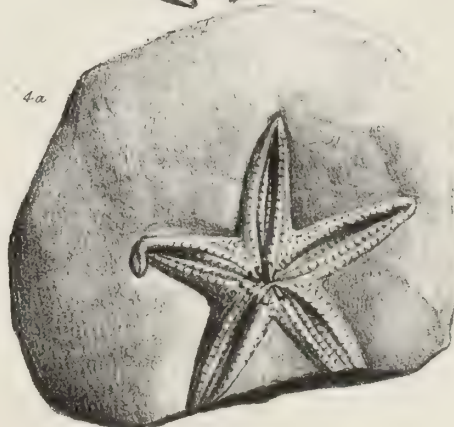
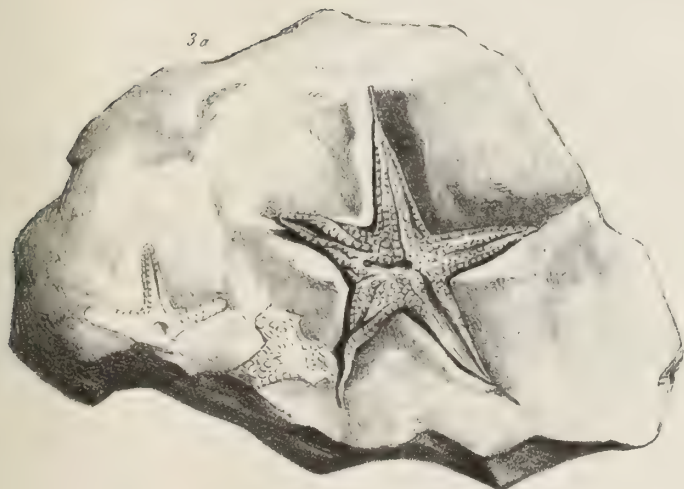
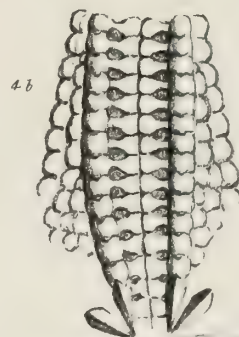








PLATE VII.

ASTROPECTEN LECKENBYI, *Wright*.

*From the Inferior Oolite.*

FIG.

- 1 *a.* ASTROPECTEN LECKENBYI, *Wright*, p. 114. Dorsal surface, natural size.  
*c.* Two of the marginal plates, magnified four times, to show the size and arrangement of the tubercles on their surface.  
*b.* Lateral view of the same specimen, showing the thickness of the border and a section of the marginal plates.

ASTROPECTEN SCARBURGENSIS, *Wright*.

- 2 *a.* ASTROPECTEN SCARBURGENSIS, *Wright*, p. 115. Dorsal surface, natural size.  
*b.* Portion of one of the rays, magnified four times.  
*c.* Two marginal plates, exhibiting the tubercles on their surface.

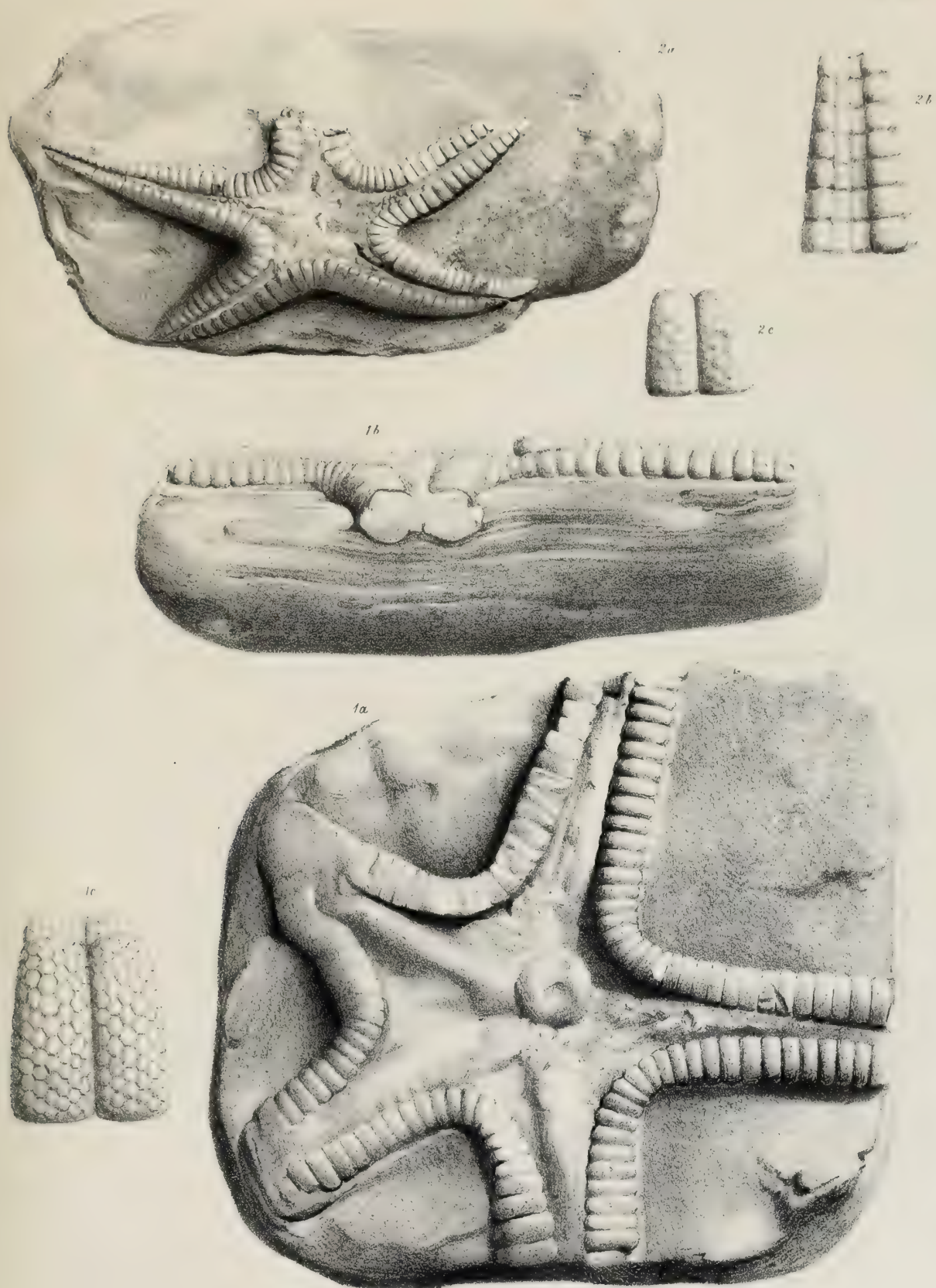








PLATE VIII.

ASTROPECTEN HUXLEYI, *Wright*.

*From the Forest Marble.*

FIG.

- 1 *a.* ASTROPECTEN HUXLEYI, *Wright*, p. 123. Ventral surface, natural size.
- b.* Dorsal surface of the same specimen, with one ray everted, and showing both sides of the same individual at one view.
- c.* Two marginal plates, with the combs of spines attached to the small inter-ambulacral bones, magnified four times.
- d.* Another view of the same plates, with the large spines, magnified four times.

ASTROPECTEN COTTESWOLDIÆ, var. STONESFIELDENSIS, *Wright*.

*From the Stonesfield Slate.*

2. ASTROPECTEN COTTESWOLDIÆ, var. STONESFIELDENSIS, *Wright*, p. 121. Dorsal surface, natural size.
3. Ossicula of ASTERIADÆ, magnified four times.
4. Ditto magnified four times.
5. Ditto magnified four times.
6. Marginal plates of an *Astropecten*, magnified four times.
7. Ditto ditto magnified four times.
8. Ditto ditto magnified four times.

All these separate bones were collected from the Great Oolite.









PLATE IX.

ASTROPECTEN COTTESWOLDIÆ, *Buckman*.

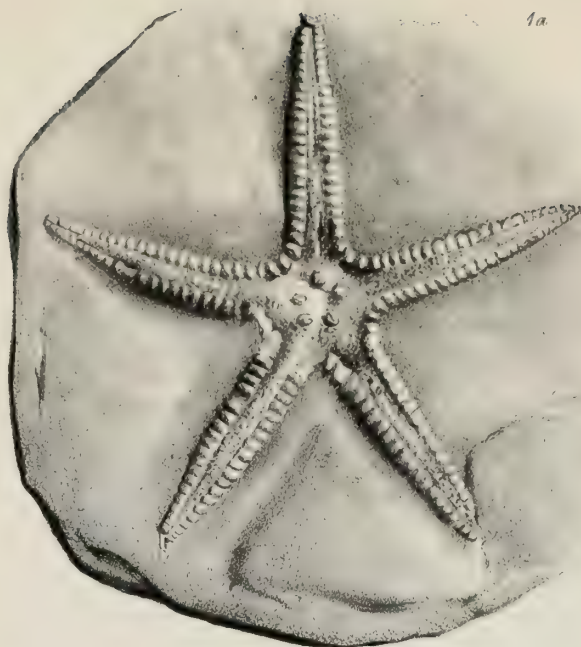
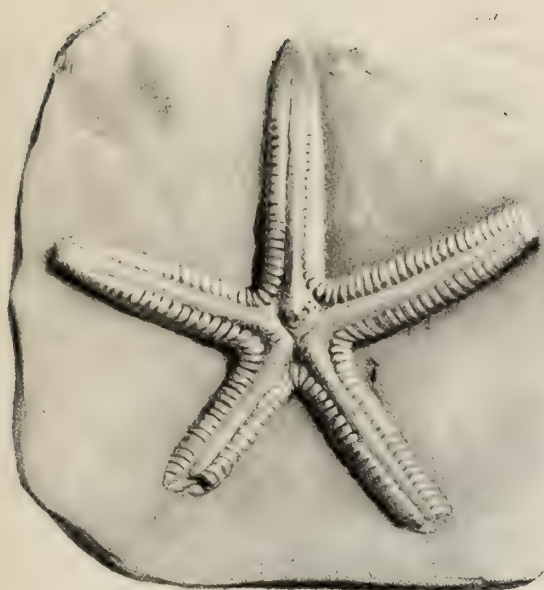
*From the Stonesfield Slate.*

FIG.

- 1 *a.* ASTROPECTEN COTTESWOLDIÆ, *Buck.*, p. 116. Dorsal surface, natural size.  
*b.* Disc of this specimen, magnified to show the madreporiform body with its radiating laminæ, and the five prominent oblong bodies formed by the upper portions of the ambulacral bones.  
*c.* Portion of the upper surface of a ray of another specimen, showing the extension of the ambulacral bones throughout the ray.  
*d.* Three marginal ossicula, magnified four times, showing the small granules on their convex surface.
- 2 *a.* ASTROPECTEN WITTSII, *Wright*, p. 120. Dorsal surface, natural size.  
*b.* Portion of the disc and ray, showing the madreporiform body and marginal plates of this species, magnified three times.
- 3 *a.* ASTROPECTEN COTTESWOLDIÆ. Another specimen, with a wider disc.  
*b.* Portion of a ray magnified twice, showing the marginal plates, and the intermarginal ossicles.  
*c.* Two marginal plates, magnified four times.
4. ASTROPECTEN COTTESWOLDIÆ. Another specimen, dorsal surface, natural size.



1a



2b



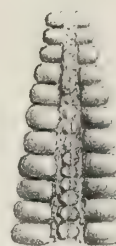
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1d



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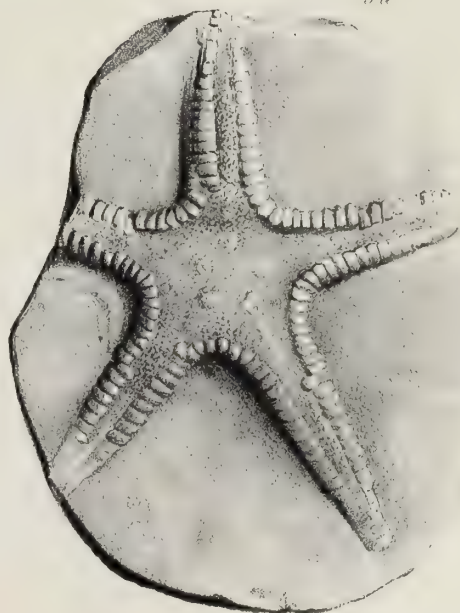
3c



3b



3a









## PLATE X.

### ASTROPECTEN COTTESWOLDIÆ, *Buck.*

*From the Stonesfield Slate.*

FIG.

- 1 *a.* ASTROPECTEN COTTESWOLDIÆ, *Buck.*, p. 116. Ventral surface, natural size.  
*b.* Disc and portion of ray, magnified three times.  
*c.* Portion of the ventral surface of a ray, magnified six times, showing the marginal bones with their lateral spines, and the ambulacral avenue.  
*d.* Lateral view of a ray, magnified four times, showing the thorn-like spines attached to the distal border of the marginal plates.

### ASTROPECTEN PHILLIPSII, *Forbes.*

*From the Forest Marble.*

- 2 *a.* ASTROPECTEN PHILLIPSII, *Forbes*, p. 122. Ventral surface, natural size.  
*b.* Portion of a ray, showing the ambulacral bones, avenue, and tentacule pores, magnified.  
*c.* One marginal bone magnified.  
*d.* Two marginal bones with their border spines, magnified.  
*e.* Spine magnified.

### ASTROPECTEN COTTESWOLDIÆ.

- 3 *a.* ASTROPECTEN COTTESWOLDIÆ. Small specimen, showing details of the dorsal surface of the rays.  
*b.* Dorsal surface, showing marginal plates, and the upper portion of the ambulacral bones.  
*c.* Ditto ditto of another ray.  
*d.* Ditto ditto of another ray.

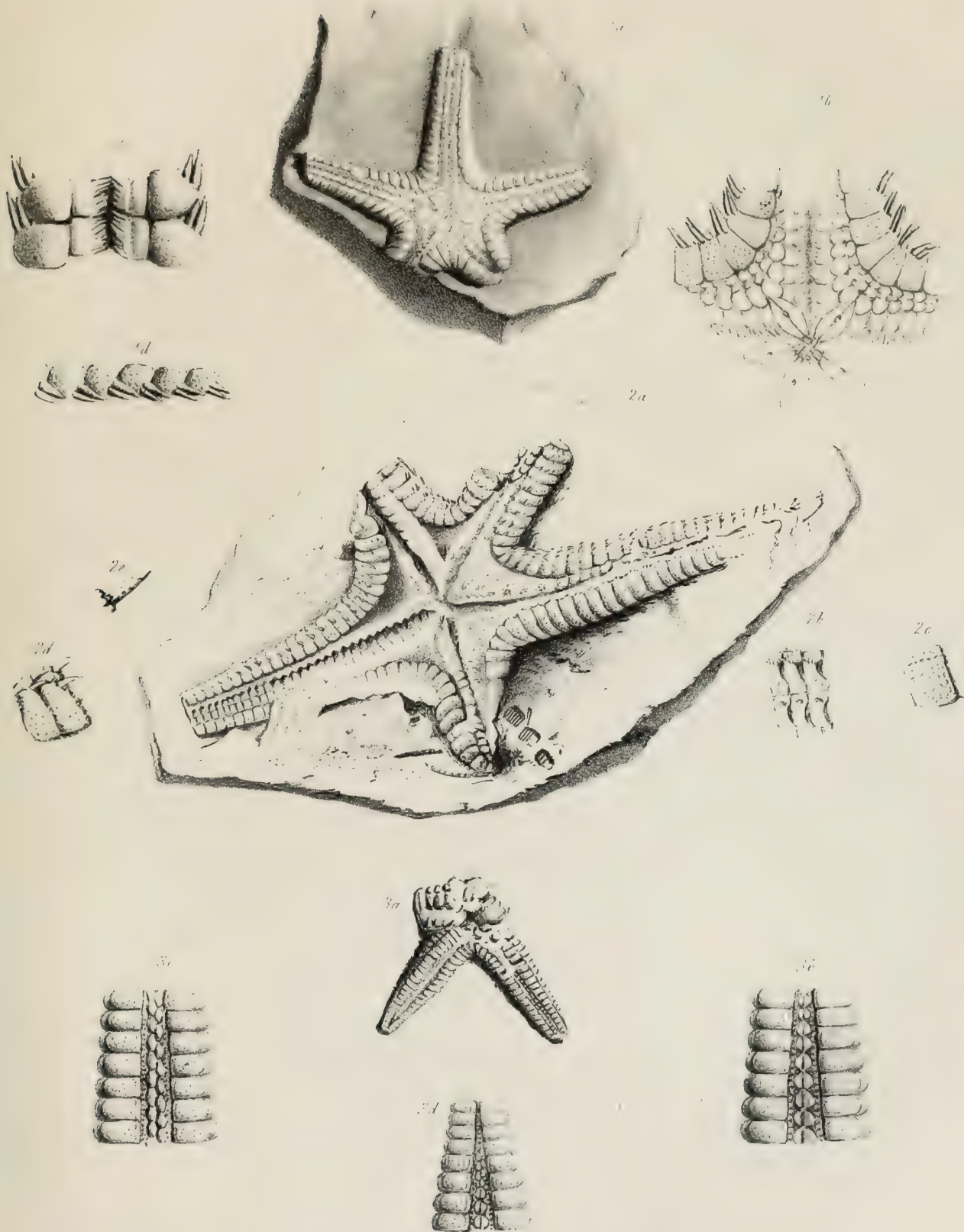








PLATE X A.

ASTROPECTEN ORION, *Forbes*.

*From the Kelloway Rock.*

FIG.

1. ASTROPECTEN ORION, *Forbes*, p. 127. Ventral surface, natural size.
2. ASTROPECTEN CLAVIFORMIS, *Wright*, p. 125. Ventral surface, natural size ; this is a four-rayed variety of the large species, figured in Plate XI.
3. ASTROPECTEN PHILLIPSII, *Forbes* (?). Copy of the figure of an *Astropecten* found in the Cornbrash, near Yeovil, from the 'Magazine of Natural History,' vol. ii, p. 73, for 1829.

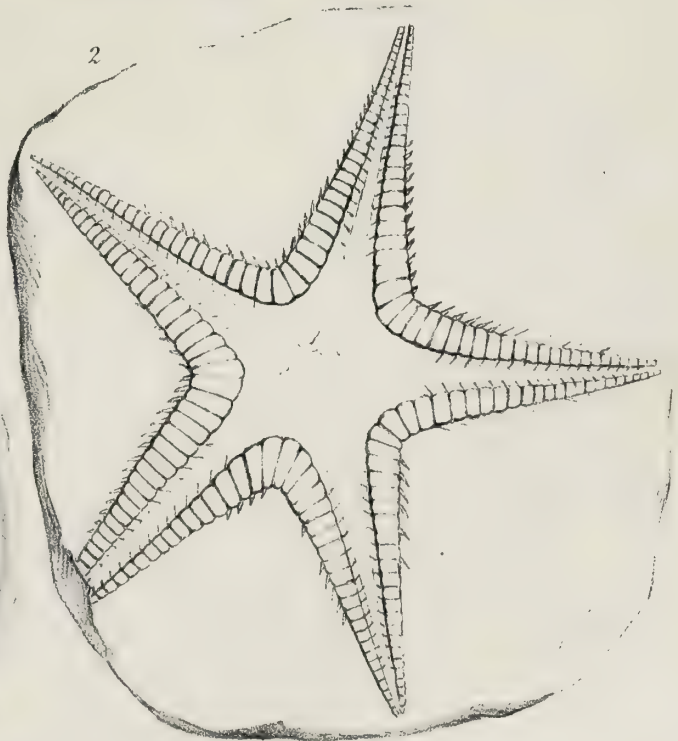
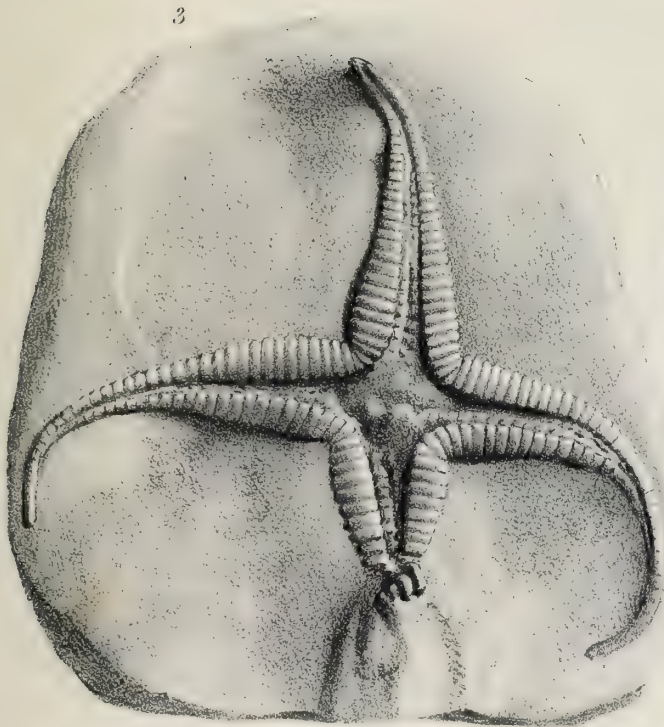
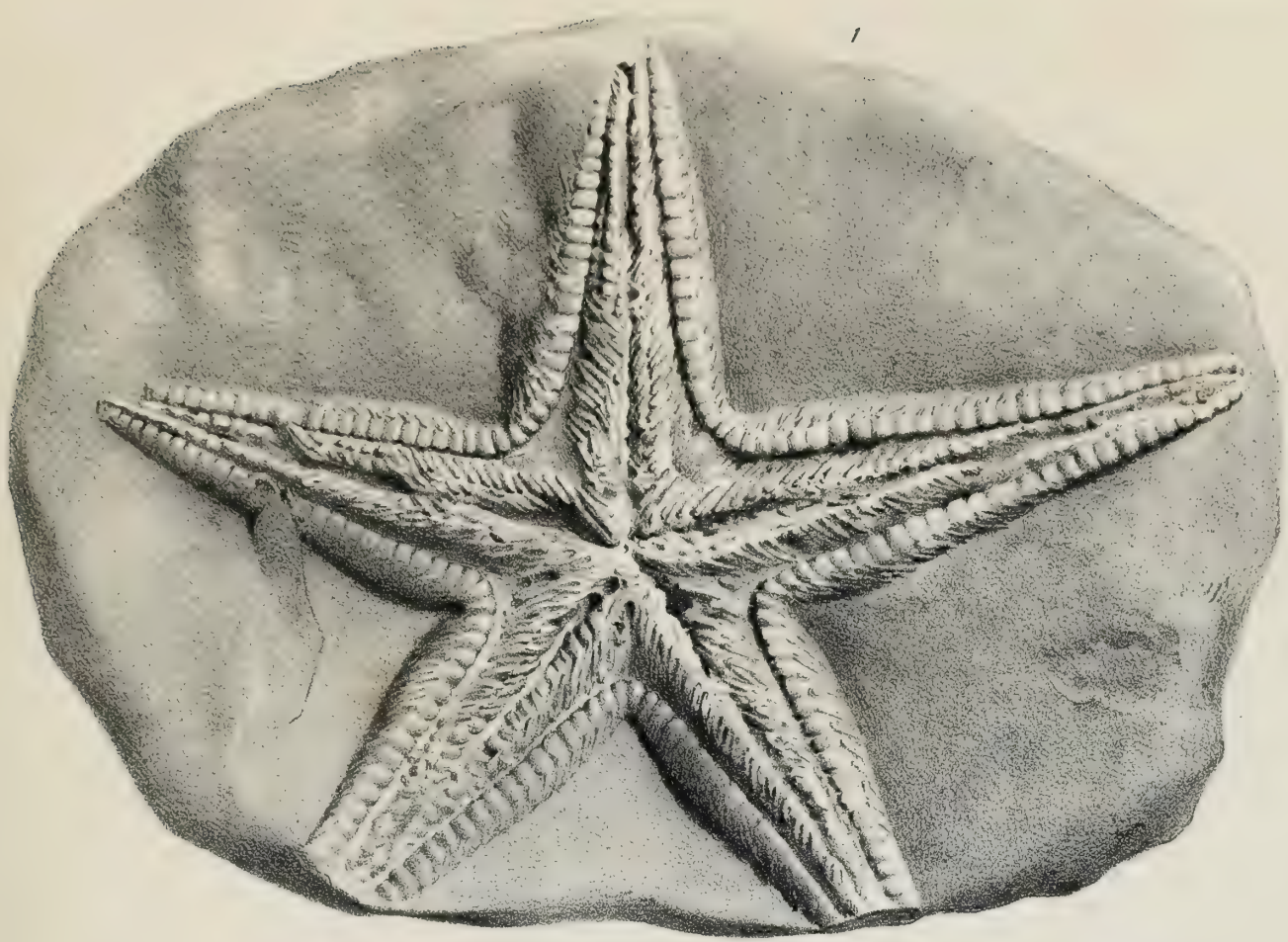








PLATE XI.

ASTROPECTEN CLAVÆFORMIS, *Wright*.

*From the Kelloway Rock.*

ASTROPECTEN CLAVÆFORMIS, *Wright*, p. 125. Ventral surface, natural size.



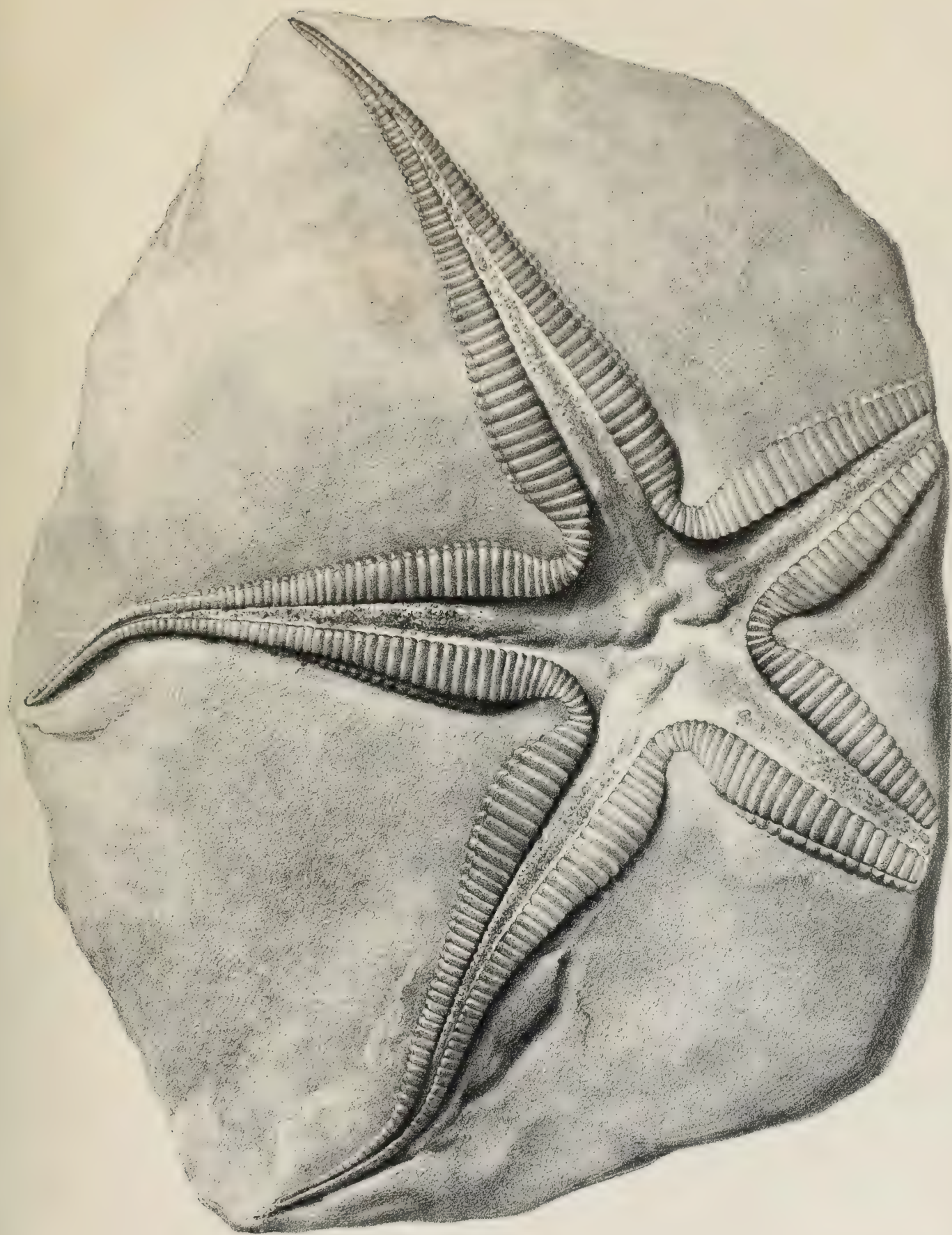








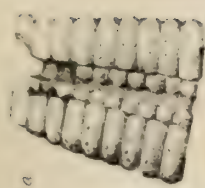
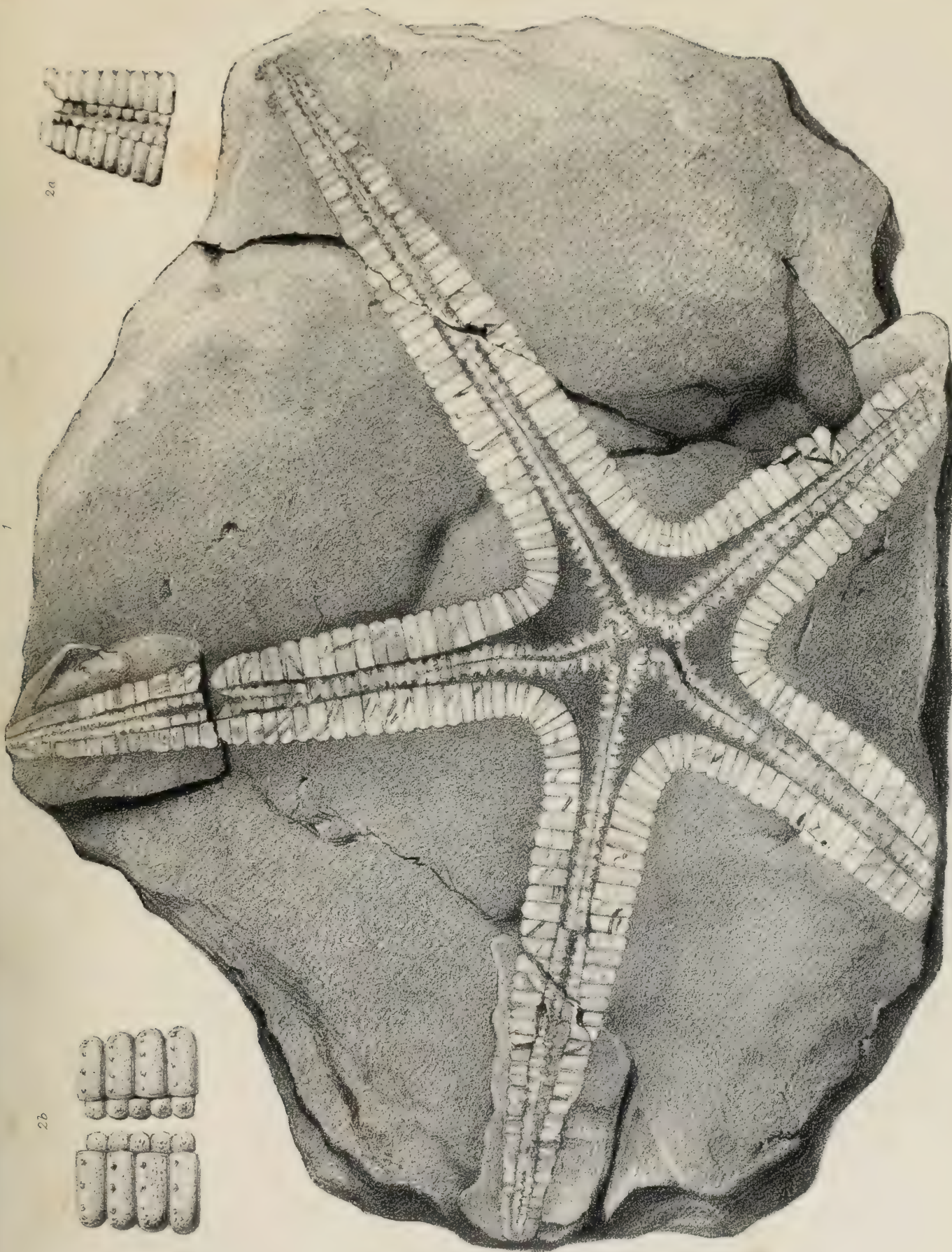
PLATE XII.

ASTROPECTEN RECTUS, *McCoy*.

*From the Calcareous Grit.*

FIG.

1. ASTROPECTEN RECTUS, *McCoy*, p. 129. Section of the skeleton, natural size.
- 2 *a*. Portion of the dorsal surface of a ray enlarged, showing the marginal plates.  
*b*. Portion of the ventral surface of a ray, showing the marginal plates, inter-ambulacral bones, and ambulacral avenue magnified.



2a



2b















THE  
PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON :

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SUPPLEMENTARY MONOGRAPH

ON THE

M O L L U S C A

FROM THE

STONESFIELD SLATE, GREAT OOLITE, FOREST  
MARBLE, AND CORNBRAH.

BY

JOHN LYCETT, M.D.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1863.



## INTRODUCTORY EXPLANATION.

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THE introduction to the first part of the 'Monograph of the Great Oolite Mollusca' contained an intimation that, with increasing knowledge of the testacea of the Cornbrash and Forest Marble, it might eventually be desirable to give an additional monograph, or an Appendix to that work. The materials which have latterly been placed at the disposal of the writer are so considerable that he has been induced to endeavour to fulfil the anticipatory announcement made in 1850, and also to correct some errors, both textual and typographical, which occur in the former Monograph. In the execution of his task the writer begs thankfully to acknowledge the assistance he has received in the loan of specimens from gentlemen whose names will be found mentioned in connexion with each of the species illustrated, nor can he omit gratefully to mention the great advantages he has derived from the constant opportunities that have been afforded to him of comparing the Oolitic fossils of the southern counties with those of Yorkshire, contained in the very extensive and choice collection of Mr. Leckenby, of this place.

SCARBOROUGH; *September 6, 1861.*





## SUPPLEMENT

10

## A MONOGRAPH

OF THE

## MOLLUSCA FROM THE GREAT OOLITE.

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### CEPHALOPODA.

AMMONITES BULLATUS, *D'Orbig.* Tab. XXXI, fig. 1.

AMMONITES BULLATUS, *D'Orb.* Pal. Fr. Ter. Jurass., p. 412, pl. 142, figs. 1 and 2.

— — *Küdernatsch.* Abhand. K. K. Geol. Reich., 1 band., taf. iii,  
figs. 1—4—11.

— PLATYSTOMUS, *Quenst.?* Cephal., t. 15, fig. 3.

— BULLATUS, *Oppel.* Juraform., p. 549.

— — *Quenstedt.?* Der Jura., t. 64, fig. 13, p. 479.

*Testá bullatá, irregulari; anfractibus subinvolutis, latis, ultimo angustato, transversim late costato; costis inæqualibus; aperturá constrictá, semilunari.* (D'Orbigny.)

Shell inflated, globose, variable in form throughout all the stages of its growth, ornamented with large, transverse, slightly elevated ribs, which pass from the umbilicus over the back to the other side, not straight, but curved forwards; these are separated by other shorter ribs, which alternate with the larger series of ribs in the adult state, but in the young state there are two and sometimes three short ribs between each of the longer ones. The volutions of the spire are irregular and embracing, forming a contracted umbilicus in the young state; subsequently the volutions are less contracted, which renders the shell unsymmetrical or deformed. The back is rounded, the mouth much contracted and prolonged in the middle part. The septa are very much complicated.

In England this Ammonite is very rare. The aged example figured is seven inches in

diameter, the aperture having a height and breadth of two inches; its more advanced growth will account for the difference of figure when compared with those of D'Orbigny, Quenstedt, and of Kudernatsch; but in truth, the variability of figure extends not less to individuals than to the stages of growth, for in no instance does there appear to be a very near agreement of figure.

*Geological Position and Localities.* The sole specimen in my collection is from the Great Oolite, near Tiltups Inn, two miles south of Nailsworth; another specimen, apparently from the same locality, is in the collection of my friend, Dr. Wright, of Cheltenham. The foreign localities are St. Maixent, Deux-Sèvres; Masigny, Vendee; Nantua, Ain; Vezelay, Yonne; Wohnkammer, Swinitza.

AMMONITES DISCUS, *Sow.* Tab. XLI, fig. 8, S a.

NAUTILUS DISCUS, *Sow.* Min. Con., 1813, i, tab. 12.

AMMONITES DISCUS, *Sow.* Ibid., 1815, Suppl. Ind. to vol. i, p. 5.

— — *Morris.* Catal., 1854, p. 291.

— — *Oppel.* Juraformation, p. 472.

*Testa discoidea, angusto umbilicato, dorse angusto acute carinatis, lateribus externe, valde compressis, lævigatis; apertura sagittæformi. Etatè juniori lateribus costis distantibus flexuosis.*

Shell discoidal, with a narrow and deep umbilical cavity, the back acutely keeled; the sides of the volutions near to the back are much flattened and smooth; the aperture is sagittate, the margin of the umbilicus is rounded. In the young state, when the diameter does not exceed three inches, the sides are ornamented with regular distant, depressed, flexuose costæ.

The lobes are comparatively simple, with few ramifications, and have but little depth; the saddles are in a corresponding manner but little produced; they therefore differ altogether from the septa of *A. discus*, D'Orbigny, and from the *A. sub-discus*, of the same author; they are, however, more complicated than is seen in *A. discus*, Quenst. ('CEPHALOPODEN,' tab. viii, fig. 13); *A. Stauffensis*, Oppell, from the inferior Oolite of Boll, Balinger, &c. They also differ from the description given by Roemer ('Nord. Ool.,' p. 190) of an Ammonite attributed by him to *A. discus*, Sow., from the lower Coral Rag of Heersum.

The general figure is less discoidal than *A. Waterhousei*, Mor. and Lyc. (*A. discus*, D'Orb.); it differs also from that species by the absence of the flattening upon the inner portion of the sides of the volutions. From *A. sub-discus*, D'Orb., the general figure differs in the more acute back and in the smaller umbilicus.

The specimen figured in the 'Mineral Conchology,' is an adult shell, and smooth; the fine specimen selected for our illustration exhibits the septa, and also some traces of the falciform costæ proper to the young shell. I am obliged to Mr. Woodward, of the British



Museum, for information respecting it, and also for a careful drawing which exhibits its palæontological features; the specimen was obtained in the Bradford Clay of the Tetbury Road Railway Station, near Cirencester, by Professor Coleman, of the Royal Agricultural College.

*Geological Positions and Localities.* It has occurred at several localities in the Cornbrash, as at Wollaston, Chippenham, Trowbridge, and in Bedfordshire, but it is everywhere rare; to these positions must be added the single specimen above alluded to from the Bradford Clay, and another, in the British Museum, from the slate of Stonesfield.

## GASTEROPODA.

BRACHYTREMA VARICOSA, *Lyc.* Tab. XLIV, fig. 27.

*Testa parva ovata, gibbosa, spira anfractibus 5 subplanis, costis transversalibus et longitudinalibus inæqualibus cruciatis; granulatis, granulis magnis, depressis, ultimo anfractu varicibus irregularibus duobus; apertura sinuosa, columella arcuata, canali breviusculo.*

Shell small, ovate, gibbose; spire elevated, obtuse, consisting of five, flattened volutions, with well-marked sutural depressions; encircling costæ five, of which the first and last are large, forming elevated bands, the three intermediate costæ being smaller, irregular, and unequal; they are decussated by very irregular, granulated, straight costæ, which occasionally form large varices, of which the last volution has two; these impart a distorted aspect to the lower part of the shell; the aperture is rather narrow and sinuated, the columella much curved, the canal short, the notch narrow and deep; the outer lip is thickened, but imperfect.

A short, ovate shell, with strongly marked and very irregular ornamentation; the varices are prominent only upon the two latter volutions; the straight costæ are very irregular, sometimes crowded, but occasionally very distantly arranged; the basal canal is unusually short, and curved forwards; the lips are without denticulations.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common; very rare, two specimens.

BRACHYTREMA BUCCINOIDEA, *Lyc.* Tab. XLIV, fig. 17.

*Testa turriculata, ovali ventricosa, anfractibus 5—4 convexis, suturis valde impressis, longitudinaliter costatis, costis 14—16 rectis, transversim finissime lineatis, anfractu ultimo magno, rotundo, basi attenuato, canali brevi, obliquo; apertura superne et inferne constricto.*

Shell turreted, ovately ventricose, volutions 5—4, convex, the sutures deeply impressed, longitudinally costated; the costæ, from 14 to 16 in a volution, are perpendicular, and not very strongly defined; they are decussated by fine, encircling lines; the last volution is

large, rounded, attenuated at the base; the canal is short and oblique; the aperture is much contracted at the two extremities.

*Geological Position and Locality.* The Great Oolite of Minchinhampton, collected by E. Witchell, Esq., of Stroud.

PURPUROIDEA INSIGNIS, *Lyc.* Tab. XXXI, fig. 2, 2 a.

PURPUROIDEA INSIGNIS, *Lyc.* Cotteswold Hills Handbook, &c., pl. 7, fig. 8, a, b.

*Testa turbinata, ovata, inflata, spira exserta, anfractibus 5 subangulatis, tuberculis depressis (9 in ambitu), anfractu ultimo magno inflato, plerumque sine tuberculis; aperturá magná ovatá, canali leviter excavato*

Shell turbinated, ovate, inflated; spire half the length of the aperture; volutions (5) slightly angulated and flattened upon their upper surfaces, with nine small, depressed tubercles upon each volution; the last volution large, ventricose, rounded, the latter half of the circumference being destitute of tubercles, and having only oblique folds of growth; aperture ovate, columella with an umbilical groove; the basal notch is only slightly defined, the junction of the columellar and outer lips forming a gentle curvature. The shorter, angular spire, depressed tubercles, and ventricose figure of the last volution, serve to distinguish it from *P. nodulata*, the species to which it is most nearly allied. The expanded base, wide, shallow, or obsolete notch, and rounded columella, so constant in all the species of Purpuroidea, appear to me to justify a generic separation from the recent *Purpura*, to which they have been reunited by some French palæontologists of eminence. The genus *Purpurina* of D'Orbigny, exemplified by his type *P. Bellona*, is separated from Purpuroidea both by the figure of the aperture and by his description, in which the contracted basal canal is insisted upon; other so-called examples of *Purpurina*, in the 'Paléontologie Française,' as *Ornata*, *Bianor*, *Bixa*, and *Bathis*, have, together with a thin shell, a lengthened, subulate figure and an entire aperture; these should be placed with the Littorinidæ, and should range by the side of *Amberleya*, figured and described in the first part of this monograph. I am inclined to claim for *Amberleya* a more important position than that of a sub-genus.

The Great Oolite species of Purpuroidea have, however, been merged by Professor Morris ('Catalogue') and by Dr. Oppel ('Juraformation') with *Purpurina*.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common, associated with other species of the same genus.

CERITHIUM BATHONICUM, *Lyc.* Tab. XLIV, fig. 19.

*Testa parva subconica, apice obtuso, anfractibus látis, paucis, plánis; costis (7) rectis magnis, obtusis, striisque cingendis; apertura parva, cauda brevi.*

Shell small, somewhat conical; apex obtuse; volutions wide, few, flattened; costæ (7)

straight, large, obtuse, encircled with regular striations ; sutures of the volutions distinctly marked.

The costæ form straight, rounded elevations, which pass the whole length of the spire, and are only slightly interrupted by the sutures, the height of each volution being equal to about two thirds of its opposite measurement. It appears to be rare.

Length three lines, breadth half the length.

*Geological Position and Locality.* The upper beds of the Great Oolite near Bath, associated with numerous other minute testacea, collected by Charles Moore, Esq.

CERITHIUM BULIMOIDES, *Desl.* Tab. XLIV, fig. 3.

CERITHIUM BULIMOIDES, *Deslongchamps.* Mém. Soc. Linn. de Normand., 1848,  
vol. viii, pl. 11, fig. 40.

— — — *D'Orb.* Prodr., i, p. 303.

*Testa minima, elongato-turrita, acuta, anfractibus rotundatis, transversim striatis, longitudinaliter costatis, costis rectis, basi obliqua, transverse striata, apertura subrotunda, columella marginata, canali nullo.* (Deslongchamps.)

Shell minute, elongated, turreted, acute ; volutions (8) slightly convex, wide, transversely striated and longitudinally costated ; costæ about 8 in a volution, perpendicular and obtuse ; the sutures are deeply impressed, the aperture is oblique and rounded ; there is no basal canal.

The costæ, which are large and elevated, are slightly knotted where they are crossed by three encircling lines in each volution ; our specimen is imperfect at the base.

*Geological Position and Localities.* The Great Oolite of Minchinhampton, collected by E. Witchell, Esq. France, Luc.

CERITHIUM MULTIFORME, *Piette.* Tab. XLIV, fig. 20.

CERITHIUM MULTIFORME, *Piette.* Bull. Soc. Géol. Fr., 2 ser., t. 14, pl. 5, p. 553.

*Testa parva elongato conica, anfractibus (9—10) angustis, convexis, suturis valde impressis, costis subobliquis (10 ad 12 in ambitu), magnis, lincis cingendis (5) æqualibus ; anfractu ultimo ad basin lineato, cauda brevi.*

Shell small, elongated, conical ; volutions (9—10) narrow, convex, the sutures deeply impressed ; costæ large, from 10 to 12 in a volution, longitudinal, but slightly oblique, and knotted by five rows of regular encircling lines, the last volution has encircling lines at the base ; the canal is short.

The tumid, narrow volutions, large costæ, and deep sutures, afford strong distinctive characters, the height of each volution being only slightly greater than a third of its opposite measurement. The specimens figured by M. Piette vary much in the elevation of the spire, and consequently in the breadth of the volutions ; the number of costæ likewise differ.



*Geological Position and Locality.* The Great Oolite of Kirklington, Oxon, collected by J. F. Whiteaves, Esq. Eparcy, France.

CERITHIUM? STRANGULATUM, *Archiac.* Tab. XLIV, fig. 2.

A shorter and less cylindrical variety of this species was figured in the first part of the 'Great Oolite' Monograph, plate ix, fig. 18. The present specimen, which agrees more nearly with the example figured by D'Archiac, has *seven* longitudinal costæ, which are conspicuous *even to the base*; the contracted, pupæform aperture, with its prominent lips, is alike in both varieties.

*Cerithium strangulatum*, *C. Bulimoides*, *C. spiculum*, and *C. exigua*, belong to a small group of minute, subcylindrical shells, with prominent, longitudinal costæ, and small, thickened, orbicular apertures, which have been referred to *Cerithium* and to *Rissoa*; perhaps eventually it may be deemed proper to separate them under a new generic appellation.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common; rare.

CERITHIUM UNDULATUM (var.), *Desl.*, sp. Tab. XLIV, fig. 6.

MELANIA UNDULATA, *Deslongchamps.* Mém. Soc. Linn. de Normand., 1842, vol. viii, pl. 11, fig. 58, var. *a*.

*Testa turrita; anfractibus planis, transversim striatis, ad suturas crenulatis, longitudinaliter costatis, in ultimo anfractu costis subincurvis, basi obliqua, striata; apertura elliptica, obliqua, columella marginata; labro sinistro fissuram umbilicatem obtigente.*

*Var. a, testa breviori, costis et striis crassioribus, rariorisque.* (Deslongchamps.)

Shell minute, turreted; volutions flattened, transversely striated, crenulated near to the sutures, and longitudinally costated; aperture elliptical, oblique.

Our example constitutes a small and short variety, with narrow volutions (about 5); the costæ are large, straight, and from 7 to 8 in a volution; they are most conspicuous near to their upper extremities, which project, forming a kind of coronary border immediately beneath the suture. Another minute specimen, apparently belonging to the same variety, has the first three volutions almost plain, and the costæ upon the succeeding volutions are but little prominent.

The typical form of the species figured by M. Deslongchamps has the costæ much more numerous and less prominent.

*Geological Position and Locality.* The Great Oolite of Minchinhampton, collected by E. Witchell, Esq.

RISSEA? EXIGUA, *Lyc.* Tab. XLIV, fig. 11.

*Testa parva, ovato-conica, spira anfractibus (6) plano-conveaxis, angustis, suturis valde impressis, costis longitudinalibus rectis, angustis, 8—9 in ambitu; apertura, parva, suborbiculari, labro externo simplici.*

Shell small, ovately conical; spire consisting of six flattened or slightly convex, narrow volutions, the sutures being strongly marked; longitudinal costæ elevated, narrow, perpendicular, 8 to 9 in a volution; aperture small, suborbicular, outer lip simple.

A minute lenticular shell, with about eight and a half costal spaces to a volution, the height of each volution being equal to the half of its transverse diameter; the apex is slightly obtuse, and the last volution is somewhat contracted.

*Geological Position and Locality.* The Great Oolite of Bussage, collected by Mr. Witchell.

CERITHIUM? SPICULUM, *Lyc.* Tab. XLIV, fig. 1.

*Testa ovato-elongata, minuta, anfractibus (6) latis subplanis, transversim striatis et longitudinaliter costatis; costis rectis (6 in ambitu), anfractu ultimo cylindrico, apertura parva, ovata, canali nullo.*

Shell minute, ovately elongated subcylindrical; volutions (6) wide, rather flattened, transversely striated, and longitudinally costated; costæ straight, six in a volution; the last volution is nearly cylindrical; the aperture is small, ovate; there is no canal.

The costæ, which have little prominence, appear to stretch continuously; the length of the shell only slightly interrupted by the sutures, which are not strongly marked; the aperture is pupæform; the general figure approximates to *C. strangulatum*, but more lengthened, and with higher volutions.

*Geological Position and Locality.* The Great Oolite of Minchinhampton.

CERITHIUM? COMPOSITUM, *Lyc.* Tab. XLIV, fig. 9.

*Testa parva, elongato-conica, anfractibus (6) angustis subplanis, transverse striatis et costatis; scilicet anfractu ultimo et penultimo costis crebris longitudinalibus rectis, circa 18 in ambitu; apertura parva, obliqua, ovata, depressa.*

Shell minute, conical, elongated; volutions (6) narrow, flattened, transversely striated, and longitudinally costated; but the costæ are limited to the two or three latter volutions, they are closely arranged, little elevated, and about eighteen in a volution; the aperture is depressed, oblique, and ovate.

*Geological Position and Locality.* The Great Oolite of Minchinhampton, collected by Mr. Witchell.

CERITHIUM? WITCHELLI, *Lyc.* Tab. XLIV, fig. 7.

*Testa minuta subcylindrica, elongata, anfractibus (5—6) subconvexis altis, suturis valde impressis, costis (circa 15) depressis subrectis, superne distinctis, inferne evanescentibus apertura ovata, labro externo simplici.*

Shell minute, subcylindrical, lengthened; volutions (5—6) high, rather convex, the sutures depressed and strongly defined; costæ (about 15 to a volution) depressed, distinct at the upper and vanishing towards the lower part of each volution; the aperture is of moderate size, ovate, the lips rather thickened.

The breadth of each volution is about one third more than its height; the costæ are only faintly marked; there are no traces of encircling striations or tubercles.

*Geological Position and Locality.* The Great Oolite of Minchinhampton, communicated by E. Witchell, Esq.

CERITHIUM? PULCHRUM, *Lyc.* Tab. XLIV, fig. 4.

*Testa parva, crassa, turrito-subulata, anfractibus (8) convexis, suturis valde impressis, costis transversis, obliquis, magnis (circa 12 in ambitu), lineis longitudinalibus decussatis, apertura parva ovata, canali nullo.*

Shell small, thick, elongately turreted; volutions 8, convex, the sutures deeply impressed; transverse costæ about 12 to each volution, oblique, large, decussated, and rendered nodulous by six narrow encircling lines; aperture ovate, rather contracted; no canal.

Allied to *Cerithium costellatum*, Desh., from which it differs in having fewer volutions, and in possessing encircling lines. *C. bulimoides*, Desh., with a similar general figure, has the costæ smaller, fewer, and perpendicular.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common, collected by Mr. Witchell.

NERINÆA GRANULATA, *Phil.*, sp. Tab. XXXI, figs. 12, 12 a.

TEREBRA GRANULATA, *Phil.* Geol. York., i, pl. 7, fig. 16, p. 173.

CERITHIUM GRANULATUM, *Mor.* Cat. Brit. Foss., 1854, p. 240.

*Testa subulato-turrita, anfractibus numerosis angustatis, planis, sed inferne subconcavis,*



*lineis subnodulosis irregularibus, inæqualibus (9-10) cingendis; apertura obliqua, columella uno plicato.*

Shell elongated, turreted; volutions numerous (about twenty), narrow, flattened, but slightly contracted towards the base of each volution, and encircled with numerous (nine or ten) irregular, unequal, slightly nodulous lines; the aperture is small, subquadrate, and oblique, the columellar lip has a single strong plication.

The volutions are narrow, so that their height is little more than the half of their opposite diameters; the upper border of each is rendered prominent by the slight contraction towards the base of each volution; the single strong fold upon the pillar lip, and a trace of another mesial fold upon the outer lip, is all that can be ascertained from the single specimen at our disposal, which is also the type figured by Professor Phillips. Sixteen volutions are preserved, but probably four more would be required to render the spire perfect. *Nerinea fasciata*, Voltz, approaches this species nearly, both in the general figure and in the ornamentation; judging, however, from specimens obtained in the Coral Rag of Yorkshire, the latter has the encircling lines more regularly disposed, and more constantly and regularly nodulous; the spiral angle also appears to be somewhat greater: it is therefore preferable to regard them as distinct species. The length of the imperfect specimen above referred to is an inch and a half, to which should be added two lines to perfect the spire; the transverse diameter of the last volution is three lines.

*Geological Position and Locality.* The sole example in the Scarborough Museum was obtained in the Cornbrash of that locality.

CERITELLA MINUTISSIMA, *Lyc.* Tab. XLV, fig. 5.

*Testa minuta, elongata, spira anfractibus (4) elevatis, subplanis; aperura ovato-elongata; columella contorta.*

Shell minute, elongated; spire with the volutions elevated, smooth, and flattened; the last volution is large, moderately convex, attenuated towards the base; the aperture is of moderate dimensions, ovately elongated; the columella is contorted at the base, as is usual in the genus.

The length of the aperture slightly exceeds one third that of the entire shell. It is allied to some of the varieties of *Ceritella parvula* (Actæonina), but is more subulate; it also approaches to *Tubifer Gerandoscus*, Piette, but is less attenuated than the latter shell.

*Geological Position and Locality.* Obtained, both by Mr. Witchell and myself, in the Great Oolite of Minchinhampton.

CERITELLA LYCETTEA, *Buv.*, sp., *Lyc.* and *Mor.*, sp.

CERITELLA RISSOIDES, *Mor.* and *Lyc.* Gr. Ool. Monog., i, tab. 9, p. 7, 1850, non *Pleurotoma rissoides*, *Buv.* Mém. Soc. Verd., t. ii, pl. 6, fig. 9.

ORTHOSTOMA LYCETTEA, *Buv.* Paléont. de la Mense Atlas, p. 32, 1852.

TUBIFER PLICATUS, *Piette.* Bull. de la Soc. Géol. de France, 2 sér., t. xiii, pl. 13, p. 587, figs. 7—8, 1857.

I avail myself of the opportunity of giving another figure of this pretty species of *Ceritella*, as the magnified figure in Plate IX does not sufficiently exhibit the neatness and angularity of the volutions of the spire. M. E. Piette, in a memoir entitled "Description des Ceritheum enfouis dans les dépôts bathoniens de l'Aisne et des Ardennes," published in the work above quoted, rejects the claim of *Ceritella* to be regarded as a new genus; but figures the present and also another Minchinhampton species of *Ceritella* as examples of his proposed *new genus Tubifer*, under the names of *Tubifer plicatus* and *Tubifer Acteoniformis*. It is a satisfaction to discover this singular and unwitting testimony to the correctness of our appreciation of this generic form.

In the Atlas to the 'Palæontology of the Mense,' page 32, M. Buvignier shows that we were mistaken in supposing that our little *Ceritella* is the *Pleurotoma rissoides* of that author's memoir above quoted, and which he subsequently assigned to his proposed new genus *Orthostoma*; in this instance, also, our genus *Ceritella* has the priority.

CERITELLA MORRISEA, *Buv.*, sp. Pl. XLIV, fig. 22.

CERITELLA LONGISCATA. Gr. Ool. Monog., i, tab. 9, fig. 14, p. 40, non *Pleurotoma longiscata*, *Buvig.* Mem. Soc. Phil. Verdun, pl. 6, fig. 8.

ORTHOSTOMA MORRISEA, *Buvig.* Paléont. de la Mense Atlas, p. 32.

In this, as in the last species, the indifferent figures in the earlier memoir of M. Buvignier led to the error of assigning our Great Oolite shell to his *Pleurotoma longiscata*; the specific name proposed by that gentleman in his 'Palæontology of the Meuse' is here adopted.

CERITELLA FUSIFORMIS, *Lyc.* Tab. XLV, fig. 4.

*Testa parva elongata, fusiformi, læve; anfractibus 5, latis, subplanis, anfractu ultimo magno, subcylindrico, apertura elongata, angusta, antice et postice valde contracto.*

Shell small, elongated, fusiform, smooth; spire moderately elevated; volutions 5, wide and nearly flat, the last volution large and cylindrical; the aperture is elongated, narrow, and much contracted at both its extremities, its length slightly exceeding that of the spire.

More fusiform than other known English examples of the genus.

*Geological Position and Locality.* The Great Oolite of Minchinhampton, collected by Mr. Witchell.

NATICA HULLIANA, *Lyc.* Tab. XLI, fig. 2.

*Testa ovata, subglobosa lævi; anfractibus 6 valde convexis, suturis profunde impressis, spira elevato, acuto; apertura oblique ovali, antice rotundata postice angulata; columella callosa, umbilico nullo.*

Shell ovate, subglobose, smooth; volutions (6) very convex, the sutures deeply impressed; the spire is elevated, acute, the last volution being very large; the aperture is ovate, oblique, the anterior side rounded, the posterior side acute, the length exceeding a moiety of that of the entire shell; the columella is rounded, thickened, and there is no umbilicus.

Allied to *N. intermedia*, Tab. VI, fig. 1, but with a more elevated acute spire, more deeply depressed sutures, and a more globose ultimate volution; specimens vary somewhat in the figure of the last volution, but the acute, elevated, deeply sutured spire will always serve to distinguish it.

*Geological Positions and Localities.* I have obtained it in the Great Oolite of Minchinhampton, and in the Inferior Oolite of the same locality; Mr. Whiteaves has also kindly forwarded to me a specimen from the Great Oolite of Kirklington, Oxon; the latter, which is a young form, has the last volution slightly more globose than in the other examples.

EULIMA? LÆVIGATA, *Lyc.* Tab. XXXI, fig. 3.

*Testa parva lævigata, subulata, acuta, anfractibus (circa 10) planatis, angustis, suturis impressis; apertura suborbiculari obliquo, umbilico nullo.*

Shell small, smooth, elongated, apex acute; volutions (about ten) narrow, their sides flattened, the sutures distinct but not constricted; the aperture is obliquely orbicular; there is no umbilicus.

The height of each volution slightly exceeds the half of the opposite diameter; length, nine lines; diameter of the last volution, three lines.

Compared with *Eulima? communis*, the spire is more acute, the volutions more flattened, and the sutures are less deeply impressed.

*Geological Position and Locality.* It occurs rarely in the Cornbrash of Scarborough; the example figured is from the collection of J. Leckenby, Esq.



CHEMNITZIA VITTATA, *Phil.*, sp. Tab. XXXI, fig. 10.

MELANIA VITTATA, *Phil.* Geol. York., p. 116, pl. 7, fig. 15.

CHEMNITZIA VITTATA, *D'Orb.* Prodr., xi, et No. 29, p. 208.

— — *Mor.* Cat., 2nd edit., p. 242.

— — *Oppel.* Juraformation, p. 479.

*Testa crassa, turrita, elongata, apice acuto, anfractibus (circa 10) latis, in medio subdepressis, ad suturas elatis, carinis duobus instructis, suturis valde depressis; apertura, ovata basi angustata.*

Shell thick, smooth, turreted, elongated, apex acute; volutions (about 10) wide, rather depressed in their middle parts, elevated both above and beneath near to the sutures, forming two narrow, equal, cord-like carinæ; the sutures are deeply impressed; the aperture is ovate, rather small and contracted towards the base, where the extremity of the columella is conspicuous; the last volution is rendered somewhat angulated by the prominence of both the encircling carinæ; the surface is shining, with large plications of growth; a magnifier also discloses delicate, nearly regular, distantly arranged, encircling, granulated lines (about 20 to a volution), or when the surface has been slightly abraded, they appear as punctated striations.

Length,  $4\frac{1}{2}$  inches; transverse diameter of the last volution, 1 inch; the height of each volution is equal to 3-5ths of its transverse diameter.

The general figure is that of a lengthened cone, and the outline does not exhibit that step-like figure seen in some other allied species, as in *Chemnitzia turris* (Desl.), *C. coarctata* (Desl.), and *C. condensata* (Desl.). The two narrow and equally elevated cord-like cinctures which bound each volution, together with the somewhat angular figure of the last volution, separates it from the foregoing and all other known examples of the genus; perhaps the encircling granulated lines may also constitute a good distinctive character but it can only be discovered in very well preserved specimens. A *Chemnitzia*, in the Inferior Oolite of the Cotteswolds and of the south-western counties, which does not appear to have been figured or described, approaches near to *C. vittata*, and has sometimes been regarded as identical with it; there can, however, be no difficulty in separating specimens of the two forms, when they are well preserved. The Inferior Oolite shell is somewhat less conical, or more subulate; the sides of the volutions are more flattened; the upper cincture is rounded and distinct, but comparatively small; the lower cincture is angulated, and not cord-like; the last volution is destitute of the prominent lower cincture, which imparts an angularity to that part in the Cornbrash shell; the general figure of that volution is more lengthened and pyriform, so that the base of the aperture is wider and more produced. The Inferior Oolite shell also does not exhibit any trace of the encircling granulated lines; but possibly the test has not been preserved with sufficient delicacy to

exhibit this feature, even if it originally existed; the plications of growth are also very large, so that in the latter volutions they render the carinæ distinctly nodulous; in *C. vittata* the carinæ are but slightly modified by this cause.

D'Orbigny, 'Prodrome,' has suggested that *Nerinaea suprajurensis*, D'Archiac, may be *C. vittata*; but, judging from the figure of D'Archiac, *N. suprajurensis* is more slender, with the volutions much more numerous and more narrow, the sutures are also destitute of that deeply indented figure which is so conspicuous in our Cornbrash shell. The general resemblance which *C. vittata* bears to some examples of the genus *Nerinaea* has led me to make a longitudinal section of it, and thus to ascertain with certainty that it cannot be assigned to that genus.

*Geological Position and Locality.* The Cornbrash of Scarborough and Gristhorp; it is not rare, but is very difficult to disengage from the hard limestone.

#### KILVERTIA, *Gen. Nov.*

The views expressed on *Cerithium strangulatum*, p. 8, suggesting the propriety of erecting a new genus for the reception of that and other allied forms, have subsequently been strengthened by the examination of well-preserved specimens from the Forest Marble of Somerset and Wilts, in the collection of W. Walton, Esq., of Bath. I have now, therefore, no hesitation in proposing for these the new generic appellation *Kilvertia*, which will be found described in the Addenda.

KILVERTIA CONSTRICTA, *Lyc.* Tab. XLIV, fig. 8.

*Testa parva turrita, elongata, anfractibus (8) superne planalis, inferne ventricosis, suturis bene distinctis, lineis transversalibus et longitudinalibus, delicatissimis, cancellatis; apertura suborbiculari depressa, incrassato.*

The height of each volution is about equal to half its opposite measurement, the first encircling line beneath the suture is rather more prominent than the others; altogether there are six; their size and distances correspond nearly with the lines by which they are decussated; the aperture is imperfect at the outer lip, there is no umbilical chink.

*Geological Position and Locality.* A minute univalve, obtained by crushing shelly portions of the Great Oolite of Minchinhampton Common; Mr. Witchell has also kindly forwarded a specimen obtained by him at the same locality, and in the same manner.

*Genus*—FIBULA, *Piette*, 1857.

Description des *Cerithium enfonis* dans les dépôts bathoniens de l'Aine et des Ardennes, par M. Ed. Piette, 'Bull. de la Soc. Géol. de France,' 20 Avril, 1857.

M. Piette has founded his proposed genus upon a small group of lengthened spiral univalves which possess characters intermediate and approximating them to *Turritella* and to *Cerithium*. A rounded, straight columella, with a rudimentary umbilical groove near the base, is combined with an arcuated outer lip slightly notched posteriorly at the suture; the base of the aperture forms a slight canal at its junction with the anterior extremity of the columella, or in other instances there is no canal, the base being rounded and entire, depending upon the exact period of growth at which the animal perished; the surface of the volutions is plain, or slightly ornamented with oblique costæ. The author has figured and described several species, and has characterised his genus in the following terms:—"Le principal caractère du ce genre est d'avoir une columella droite. Le bord libre est arqué, légèrement échancré à sa partie postérieure, près de la suture. L'ombilic n'est souvent que rudimentaire, à peine indiqué, et affectant seulement la columelle externe. D'autres-fois, il pénètre tout le spire. Un caractère très curieux que j'ai remarqué sur plusieurs espèces de ce genre, mais que je n'ai pu encore constater sur toutes, c'est que la columelle se termine parfois intérieurement par un canal rudimentaire; que le mollusque forme ce canal et le rebouche tour à tour, pour le former ensuite de nouveau en grandissant. . . . Ainsi il arrive souvent que parmi plusieurs *Fibula* d'une même espèce, les unes semblent se rapprocher des *Cerithium*, les autres des *Turritelles*. Cela dépend du moment où elles ont péri."

In admitting the generic value of *Fibula*, it becomes necessary to arrange with it the following Jurassic Testacea:—*Chemnitzia phasianoides* (Mor. and Lyc.), *Cerithium Roissii* (Mor. and Lyc.), *Turritella Roissii* (D'Arch.), and *Cerithium suturale* (Buvignier). The Great Oolite of Oxfordshire and of Minchinhampton has supplied the two following additional species.

FIBULA VARIATA, *Lyc.* Tab. XXXI, figs. 4, 4 a.

*Testa turriculata, subventricosa; spira elongata, acuta, læve, anfractibus (11—12) convexiusculis, angustis, suturis valde impressis; ultimo anfractu symmetrico-curvato; columella interdum ad basin subcanaliculato, aut integro, labro sinistro arcuato.*

Shell turriculated, somewhat inflated; spire lengthened, acute, smooth, consisting of 11 or 12 narrow, somewhat convex volutions, with deeply impressed sutures; the last volution is conformable with the others, and is symmetrically curved towards its anterior



extremity ; the aperture is oblique, contracted at the base, sometimes slightly channelled, in other instances entire and rounded ; the outer lip is much curved and thin. Young specimens are less subulate, but the apex is delicately pointed, the volutions are more flattened and narrow, the sutures being less strongly marked ; the latter two or three volutions in adult specimens are more inflated, and they acquire at the base a rudimentary umbilical groove.

It is nearly allied to *Fibula nudiformis*, Piette ('Bull. de la Soc. Géol. Fr.,' 1857, pl. 6, figs. 4, 5), from the Great Oolite of Rumigny, Eparcy, Poix, But, &c. ; but, judging from the figures of M. Piette, his species has a shorter spire, with less strongly impressed sutures, and the last two volutions are more lengthened and cylindrical. *Fibula* = *Chemnitzia phasianoides*, which has the spine similarly subulate, has the volutions more flattened, and the sutures much less impressed ; other recognised species are more lengthened, with flattened volutions.

*Geological Position and Localities.* *Fibula variata* has occurred rarely in the Great Oolite of Minchinhampton, and more commonly in the same formation at Kirklington, Oxon., from which place Mr. Whiteaves has kindly forwarded specimens. Examples are deposited in the British Museum, the Woodwardian Museum, Cambridge, in the collection of Mr. Whiteaves, of Oxford, and in that of the author at Scarborough.

FIBULA EULIMOIDES, *Whiteaves*, sp. Tab. XXXI, fig. 5.

CHEMNITZIA EULIMOIDES, *Whiteaves*. MSS., 1859.

*Testa turriculata, elongata, spira apice acuto, anfractibus (circa 12) angustis, convexis superne vitta cingenda, suturis valde constrictis, ultimo anfractu rotundo ; aperturá obliquá, basí angustó subsinuató, columella umbilico rudimento ; labro externo arcuato ; anfractibus costis obliquis obscuris irregularibus.*

Shell turreted, elongated, acute ; spire with about 12 volutions, narrow, convex towards their lower parts, and encircled with a narrow band at their upper borders ; the sutures are deeply impressed ; the last volution moderately large and rounded ; the aperture is lengthened, oblique, narrow, and sinuated at the base ; there is also a rudimentary umbilical groove ; the outer lip is much arched ; the surface has irregular, oblique, obscure costæ, which resemble lines of growth in the latter volutions.

Compared with *Fibula variata*, this species is more subulate, with a shorter last volution ; the encircling band upon the upper border of each volution, the oblique costæ, and the convexity of the lower part of each volution, are also distinguishing features. *Fibula undulosa*, Piette, is more nearly allied to it, but the volutions are less narrow and more flattened or destitute of the swelling of the lower portions of the volutions which is a conspicuous feature in *F. eulimoides*. The height of each volution is equal to half of its opposite diameter.

*Geological Position and Locality.* The Great Oolite of Stonesfield, collected by Mr. Whiteaves.

RISSOINA WITCHELLI, *Lyc.* Tab. XLIV, fig. 12.

*Testa elongato-turrita, anfractibus 6, latis, convexis, aut medio angulatis, longitudinaliter costellatis, costellis circa 26—28, rectis, simplicibus, crebris; apertura ovato-obliqua, labro extus incrassato.*

Shell elongately turreted; volutions 6, wide, convex, angulated at their middle part, and encircled with a slender band at the mesial angle; the longitudinal little ribs are very closely arranged; they are smooth, narrow, perpendicular, and are united to the mesial band; from 26 to 28 in a volution; the last volution is conformable with the others, both in figure and ornamentation; the aperture is of moderate size, it is oblique, ovate, but rather pointed at the two extremities; the columella is curved in its middle; the outer lip is thickened.

The angulated figure approximates to *Rissoina duplicata*, Sow., sp., 'Gr. Ool. Mon.,' i, p. 52); but the last volution is somewhat less expanded, the costæ upon the spire are less conspicuous, and nearly three times as numerous. Mr. Witchell, who discovered the species, has kindly communicated several specimens which agree with each other in all essential particulars.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common, associated with other minute testacea.

RISSOINA MILLERI, *Lyc.* Tab. XLIV, fig. 10.

*Testa turrita subcylindrica, anfractibus (6) subconvexis, angustis, longitudinaliter costellatis; costellis 17—18, rectis simplicibus; apertura ovato-semilunari, ad basim effusa; labro extus valde incrassato.*

Shell turreted, subcylindrical; volutions (6) convex in their middle part, narrow, but with the sutures only slightly impressed; longitudinally costellated; costellæ 17—18, perpendicular, not very prominent, and plain; aperture ovately semilunar, oblique, expanded at the base, the outer lip having a considerable thickening.

Allied to *Rissoina acuta*, Sow., but having the volutions more narrow and less convex, the sutures being less deeply impressed; the little ribs are much more numerous; the aperture is also larger and more effuse at the base.

*Geological Position and Locality.* One of a series of minute univalves obtained by Mr. Whiteaves in the Great Oolite of Minchinhampton Common. The name is an acknowledgment of the discrimination of the author of 'The Natural History of the Crinoidea,' who appears to have been the first person to discover the fossil riches of this locality,



and whose strongly expressed opinion was originally the means of directing the attention of the present writer to it.

AMBERLEYA NODOSA, Tab. XLI, fig. 3; et Part 1, Pl. V, fig. 19, 1850.

This elegant shell was represented in so defective a manner at Plate V, fig. 19, as to render it desirable to give the present illustration, in which the aperture faces the spectator more directly. The examination of additional specimens has tended to confirm the views expressed in my manuscript of 1850, viz., that *Amberleya* should rank as a distinct genus of the *Littorinidæ*, separated from *Littorina* by the thin test, lengthened, almost turriculated, spire, and scarcely less so by the ornamentation of the volutions. Other examples of *Amberleya* will be found in *A. Jurassi*, Lyc. (the next species here described), *Turbo capitaneus*, Munst., *Turbo ornatus*, Sow., and some other allied Inferior Oolite species which have been figured by D'Orbigny as examples of *Purpurina*, but which are well distinguished from the type form of that genus (see the observations on *Purpuroidea insignis*). The generic appellation *Amberleya* was derived from Amberley Heath, which is a second name for Minchinhampton Common.<sup>1</sup>

AMBERLEYA JURASSI, Lyc. Part 1, Tab. IX, figs. 33, 33 a.

*Testa turbinato-conicâ, acutâ, lineatâ, anfractibus* (6) *latis, tricarinatis, carina mediana, magna, subacuta, anfractu ultimo carinis* 8, *elevatis, subacutis, striis obliquis serratis, apertura magna, ovata basi subangulato, columella recta.*

Shell turbinated or conical; spire elevated, acute; volutions (6) high, with three elevated, subacute carinæ, of which the median carina is the most prominent. The last volution is large, with eight elevated carinæ, their edges being serrated by oblique, longitudinal striations; the aperture is large, ovate, somewhat angulated at the basal junction with the columella, which is straight.

Distinguished from *Turbo capitaneus*, Goldf., both by the characters of the general

<sup>1</sup> Subsequently to the completion of this Supplement, I have been favoured by M. Eugene E. Deslongchamps with a copy of his memoir, extracted from the fifth volume of the 'Bulletin of the Linnean Society of Normandy,' 1860, entitled "*Observations concernant quelques Gasteropodes, Fossiles, des Terrains Jurassiques places par l'auteur de la 'Paléontologie Française' dans les genres Purpurina. Trochus et Turbo. Note sur le genre Eucyclus.*" The latter proposed new genus is identical with our *Amberleya*, quoted in the memoir as *Abberleya*. The author has in this little work given an excellent critical analysis of the group of which he has proposed to constitute *Eucyclus*; these are *Purpurina Patroclus*, D'Orb., *P. Philiasus*, D'Orb., *P. ornata*, D'Orb., *P. bathis*, D'Orb., *Turbo Itys*, D'Orb., *T. niceus*, D'Orb., *T. Julia*, D'Orb., *T. capitaneus*, Munst., *T. castor*, Roem., *T. princeps*, Roem. He has also figured and described the following new species—*Eucyclus obeliscus* and *E. papyraceus*, from the Upper Lias; *E. pinguis* and *E. goniatus*, from the Inferior Oolite; the latter shell, in its general figure and plan of ornamentation has a considerable resemblance to *Amberleya nodosa*. *Eucyclus* is therefore a synonym of *Amberleya*.



figure, by the greater number of carinæ, and by the absence of tubercles upon them. *Turbo castor*, D'Orbigny, resembles it in the characters of the carinæ, but they are less numerous and less elevated; the spire is also much less produced.

Height 15 lines, transverse diameter of the last volution 11 lines.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common, in which it occurs rarely in the coarse volite or planking.

AMBERLEYA ARMIGERA, *Lyc.* Tab. XXXI, fig. 6.

*Testa conica spira elata, apice acuta, anfractibus (5) convexis, subangulatis, costis tuberculosus cingendis; costis duobus superioribus minoribus, inferioribus majoribus; anfractu ultimo basi carinis serratis (5) cingendis; umbilico nullo.*

Shell conical; spire elevated, pointed; volutions (5) convex, somewhat angulated, with four encircling costæ or carinæ, which are densely and delicately tuberculated, and decussated by fine striations, the two lower costæ being much larger than the upper, so that the lowest costa overhangs the upper part of the next volution; the base has five encircling, serrated costæ; there is no umbilicus.

Height 10 lines, length of the last volution 8 lines.

The encircling carinæ occupy nearly the entire height of each volution, leaving only narrow, deep, interstitial spaces; the lowest of the carinæ is the largest. The general figure approaches to *Turbo capitaneus*, Goldf., but the latter has the encircling carinæ much more elevated, narrow, more widely separated, and less numerous. *Turbo Phillipsi*, Mor. and *Lyc.*, has a much shorter spire, with the volutions less ventricose or angulated; other species are more remotely allied.

*Geological Position and Locality.*—The Cornbrash of Scarborough, in which it is rare; from the cabinet of John Leckenby, Esq.

NERITA INVOLUTA, *Lyc.* Tab. XXXI, fig. 15.

*Testa oblique ovata, lævigata, spira parva, depressa, sub-celata, anfractu ultimo per inflato; apertura ampla, labro interno convexo.*

Shell oblique, ovate, smooth; spire (apparently consisting of two volutions) small, depressed, nearly concealed by the envelopment of the last volution, which is much inflated at the aperture; inner lip convex, smooth.

A plain species, distinguished by the great length and volume of the last volution; the apex of the spire is imperfect, but though quite depressed, probably it is not altogether concealed; the general figure is allied to *Neritina Staffensis*, Forbes, but the latter is more lengthened and more minute.

*Geological Position and Locality.* Collected by Mr. Whiteaves in the Great Oolite of Kirklington, Oxon.

NERITOPSIS ARCHIACI, *D'Arch.*, sp. Tab. XXXI, fig. 7, 7 a.

TURBO CANALICULATUS, *D'Archiac.* Mém. Soc. Géol. Fr., vol. v, pl. 29, fig. 6.

— ARCHIACI, *D'Orbigny.* Prodr., i, p. 300.

*Testa ovato-depressa, spira elata, anfractibus tribus vel quaternis, angustis, inflatis, suturis profunde canaliculatis, anfractu ultimo costis transversis obscuris, inæqualibus, irregularibus, striisque crebris decussatis; striis tenuibus, regularibus, undatis; apertura ampla, suborbiculari.*

Shell ovate, depressed; spire elevated, consisting of three or four volutions, which are narrow, inflated, their sutures deeply channeled; the last volution has some obscurely marked, irregular, and unequal transverse costa decussated by encircling striations; the striations are regular, very closely arranged, faintly impressed, with small, wave-like undulations; the aperture is large and rounded.

More depressed than *N. sulcosa* and *N. striata*, but with larger volutions, the sutures being also more deeply channeled; the ornamentation of the surface is so faintly impressed that it is scarcely perceptible without the aid of a magnifier.

*Geological Positions and Localities.* A rare species, from the Cornbrash of Scarborough, in the collection of Mr. Leckenby. Eparcy, France.

TROCHUS GUISEI, *Lyc.* Tab. XLV, fig. 14.

*Testa alta conica, apice acúto, anfractibus (6) latis, leviter concavis, anfractú ultimó subangulató, basi convexo, concentrice striato; anfractibus, costis obscuris, obliquis, ad basin bi-cinctis; apertura depressa.*

Shell elevated, conical; volutions (6) wide, apex acute, slightly concave in their middle portions; the last volution angulated; the base convex, with fine, encircling striations; the sides of the volutions have delicate, obscure, oblique costæ, which are interrupted towards the base of each volution by two narrow, encircling bands; the sutures are delicate and faintly marked; the aperture is depressed.

The ornamentation of this little Trochus is regular and but faintly sculptured; the encircling bands are rendered slightly nodular by the decussating costæ.

The name in compliment to W. V. Guise, Esq., President of the Cotteswold Naturalists Club.

*Geological Position and Locality.* The Great Oolite of Minchinhampton, collected by E. Witchell, Esq.

MONODONTA EXIGUA, *Lyc.* Tab. XLIV, fig. 29.

*Testa parva ovata, spira elata, obtusa, anfractibus tribus, subplanis, anfractu ultimo rotundo; striis tenuibus cingendis, costisque obliquis depressis, crebris, decussatis; apertura ovata, columella ad basin incrassato, subumbilicato.*

Shell small, ovate; spire elevated, obtuse; volutions three, very slightly convex, the sutures distinctly marked; the last volution rounded with densely arranged, delicate, encircling striations, which are decussated upon the upper and middle portions of the volution by numerous depressed, oblique costæ, which are rendered somewhat granular by the striations; the aperture is ovate, the columella is thickened at its base, and there is a slight umbilical depression; the base of the last volution is destitute of costæ.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common, collected by Mr. Witchell.

MONODONTA LYCETTI, *Whiteaves*, MSS. Tab. XXXI, figs. 14, 14 a.

*Testa subdepressa, spirà brevì, exserta; anfractu ultimo permagno lateribus planatis, costisque magnis, crenulatis, cingendis, basi constricta sulcò magnò.*

Shell depressed; spire short and slightly mammillated, the last volution very large, angulated at its upper margin, flattened upon its sides, and slightly convex towards the base, which has a large, encircling furrow; the aperture is moderately large, wide above, contracted towards the base; the columella is rounded and very tumid.

The whole shell is encircled with rows of rope-like crenulated costæ, the upper border and flattened sides being formed by three costæ larger than the others; beneath these are five costæ diminishing symmetrically to the basal furrrow; the upper surface, which is flattened, has three encircling costæ, within which rises a small, mammillated apex.

Lateral diameter one fourth greater than the height.

The large, rounded costæ, flattened sides, and depressed figure, readily distinguish it from allied species.

*Geological Position and Locality.* In soft, pale, gray, marly limestone (Bradford Clay?), Islip, Oxon., collected by J. F. Whiteaves, Esq.

MONODONTA SPARSISTRIATA, *Lyc.* Tab. XLV, fig. 9.

*Testa parva turbinata, depressa, spira anfractibus 4; convexiusculis, striis 6, cingendis; apertura ovata, basi subplanò, lævigato, umbilico nullo.*

Shell small, turbinated, depressed; spire moderately elevated, consisting of four rather



convex volutions, which are encircled with six regular striations ; the aperture is ovate, the base somewhat flattened and smooth ; there is no umbilical depression.

A small shell, with the last volution expanded and depressed ; the striations are rendered slightly scabrous by very delicate, obtuse, decussating ornamentation, partially preserved, and which is only visible under a considerable magnifying power.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common, collected by Mr. Witchell.

MONODONTA COMPOSITA, *Lyc.* Tab. XLV, fig. 6.

*Testa parva subdepressa, spira anfractibus 3—4 angustis, angulatis, superne concavis ; lineis angustis, regularibus subdistantibus cingendis, anfractu ultimo permagno, superne costulis depressis longitudinalibus lineis decussatis ; aperturá magná ovatá, columella solida, dentata.*

Shell small, rather depressed ; spire with the volutions (3—4), angulated in their middle part, narrow, delicate, and rather distantly arranged, the last volution is very large ; the surface above the mesial keel is concave, and has closely arranged, depressed, longitudinal, little elevations or ribs, which are rendered nodulous in their upper parts by the encircling lines ; the aperture is moderately large ; the columella has a conspicuous thickening at its base ; there is also a slight umbilical depression.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common, collected by Mr. Witchell.

SOLARIUM BATHONICUM, *Lyc.* Tab. XLV, figs. 27, 27 a, 27 b, 27 c.

*Testa parva depressa, superne planata, inferné concavó, concentricè striató ; anfractibus (3) angustis tabulatis, externe subcarinatis nodulisque paucis, obscuris, coronatis ; lateribus subconvexis striatis.*

Shell small, depressed, flattened above, concave beneath and concentrically striated ; volutions (3) narrow, tabulated, externally slightly carinated, and with a few obscure coronary tubercles ; the upper and lateral surfaces have encircling striations, the sides being slightly convex.

The specimen examined has a diameter of only two lines, the height being equal to about one third of the breadth.

*Geological Position and Locality.* The upper beds of the Great Oolite in the vicinity of Bath, collected by Charles Moore, Esq.

PLEUROTOMARIA GRANULATA, *Sow.*, sp. Tab. XXXI, fig. 8, 8 a.

TROCHUS GRANULATUS, *Sow.* Min. Con., t. 220, fig. 2.

PLEUROTOMARIA GRANULATA, *Deslong.* Mém. Soc. Linn., viii, pl. 16, figs. 6—8.

— — *D'Orb.* Prodrome, p. 267.

— — *Morris.* Cat. Brit. Foss., 1854, p. 271.

— — *Quenstedt.* Der Jura, p. 414, tab. 57, figs. 5—7.

*Testa trochiformi subturrita, apice acuta, anfractibus convexiusculis, in medio angulatis, subgradatis, superne planiusculis, inferne convexiusculis, transverse et longitudinaliter striatis; sinu angusto, fascia sinus prominente, transverse tenuissime striato, in medio anfractuum sita; ultimo anfractu ad basin subangulato, basi subconvexa, concentrice striata; umbilico minimo aut subnullo; apertura subquadrata labro sinistro crassiori reflecto.*

Shell trochiform, subturreted; apex acute; volutions rather convex, angulated in their middle portions, or somewhat step-like, the upper half of each volution being flattened, the lower half rather convex; the surface is longitudinally and transversely striated, the decussations of the striæ forming granules or tubercles, of which there are usually five rows above and four beneath the mesial angle, the uppermost row having the tubercles more prominent and separated than the others; the sinus is narrow, and of moderate depth; the fascia of the sinus is prominent, with fine, transverse striations, and placed in the middle of the volution; the last volution has the base somewhat angulated; the base is convex, and concentrically striated; the umbilicus is very small or almost none; the aperture is subquadrate, the left lip being thickened and reflected.

A beautiful species, not very regular in the disposition of the longitudinal and transverse striations, but for the most part those beneath the mesial fascia are more strongly marked than above.

The height of the entire shell and diameter of the last volution are equal in the specimen figured; others have the height somewhat greater; 16 lines is a medium size.

*Geological Positions and Localities.* The Inferior Oolite of the south-west of England and the Cornbrash of the coast of Yorkshire. Our specimen is from Gristhorpe, in the collection of Mr. Leckenby. It is moderately abundant.

CYLINDRITES EXIGUA, *Lyc.* Tab. XLIV, fig. 14.

*Testa parva, subcylindrica, spira elata conica, apice obtuso, anfractibus 5, latis, paululum convexis, spira vero lateribus subconcavis; anfractu ultimo margine rotundato, apertura angustissimo.*

Shell minute, subcylindrical; spire elevated, conical, its sides being, however, slightly concave, and its apex obtuse; the volutions are five in number, moderately wide and

slightly convex ; the last volution is lengthened, its upper margin is rounded ; the aperture is very narrow.

More lengthened and attenuated, the spire more elevated, and its apex more obtuse, than in *C. acutus*, to which species it appears to be most nearly allied.

*Geological Position and Locality.* The Great Oolite of Minchinhampton, collected by E. Witchell, Esq.

CYLINDRITES TURRICULATUS. Tab. XLIV, figs. 26, 26 a.

CYLINDRITES TURRICULATUS, *Lycett*. Proc. Geol. Soc., 1853, p. 342, vol. ix, pl. 14, fig. 8.

*Testá elongatá, subylindricá ; spirá magná, acutá ; anfractibus (8) convexis ; suturis profunde impressis ; anfratu ultimo ovato ; apertura angustata.*

Shell elongated, ovately cylindrical ; spire lengthened, its apex acute ; volutions (8 in the adult state) convex, their sutures deeply impressed, the last volution ovately cylindrical ; aperture narrow.

The general figure somewhat resembles *C. altus*, but the volutions are more numerous, and are not flattened, as in that shell ; the subovate figure and elevated spire readily distinguishes it from other contemporaneous species. The length of the aperture is equal to three fifths of the entire shell.

*Geological Position and Localities.* Formerly collected at Ponton, Lincolnshire, by Professor Morris ; recently it has been obtained in the Great Oolite of Minchinhampton by E. Witchell, Esq.

ACTEON BATHONICUM, *Lyc.* Tab. XLIV, fig. 16.

*Testa parva ovata, spira elevata, anfractibus (4) subplanis, ad suturam angulatis, suprá angulam spiratis, tabulatis, ultimó anfractû striis regularibus tenuibus ; apertura ovali, posticè angustatá.*

Shell small, ovate, spire elevated, volutions (4) rather flattened upon the sides and elevated, their superior borders forming a sharply defined angle ; above the angle is a flattened sutural area, the last volution has regular, delicate, encircling striations ; the aperture is moderately large, ovate ; the posterior extremity narrow ; its length is more than half the height of the shell.

A minute but well-marked species, with a spire larger, more lengthened, more angulated and more pyramidal than *Auricula Sedgwicki*, Phil. ; it is more nearly allied to *Tornatella Aviothensis*, Buv., 'Pal., Mense,' pl. xxiii, figs. 32, 33 ; and to *Tornatella pulla*, Kock and Dunk., 'Ool.,' pl. xi, fig. 11 ; but these have the spire more lengthened and less flattened.

*Geological Position and Locality.* One of a series of minute and, for the most part,



dwarfed testacea, collected by Mr. Moore from the upper portion of the Great Oolite in the vicinity of Bath.

*ACTEON PHASIANOIDES*, *Lyc.* Tab. XLIV, fig. 28.

*Testa parva ovato-elongata, sublæve, spira alta, turriculata afractibus 5, superne convexis, inferne planatis, anfractu ultimo magno, ovato, basi tenerrime striato, apertura elliptica, columella recta, uniplicatâ.*

Shell small, ovately elongated, nearly smooth; spire elevated, turreted; volutions 5, convex above, the sides flattened, and the sutures strongly defined; the last volution slightly exceeds half the entire length of the shell; it is ovate, its base having some delicate, regular spiral striations; the aperture is elliptical, the columella straight, having a single plication.

Possibly the entire surface may have had striations still more delicate than those at the base, but no traces of them remain; the spire is larger, and the volutions are more inflated, than is usually seen in this genus.

*Geological Position and Locality.* The Great Oolite of Minchinhampton, collected by E. Witchell, Esq.

*ACTEONINA BREVIS.* Tab. XLI, fig. 6.

Under the title of *Cylindrites brevis*, an immature and imperfect example was figured in the first part of the 'Great Oolite,' Monograph. Tab. VIII, figs. 13, 13, *a*; the fine example now figured was collected by Mr. Whiteaves in the Great Oolite of Kirklington, Oxon., and exhibits in the more advanced stage of growth a change in the last volution, whose upper margin rises higher than those of the preceding volutions, thus rendering the vertex slightly concave, a change with which recent conchology presents many analogous instances. The figure of the columella leaves no doubt that it is an *Acteonina*.

*ACTEONINA KIRKLINGTONENSIS*, *Lyc.* Tab. XLI, fig. 5.

*Testa ovato-cylindrica, elongata, lævigata, spira obtusa, perspicua, anfractibus (4) depressis, columella ad basin cortorta, apertura inferne elongata, ovata.*

Shell ovately cylindrical, elongated, smooth; spire obtuse, depressed, the upper margins of the volutions exposed and rounded; columella contorted at its base, forming with inner lip an umbilical depression; aperture narrow above, pyriform, lengthened, and rather pointed at its base.

A lengthened cylindrical *Acteonina*, with an exposed, obtuse spire, which does not rise higher than the upper border of the last volution; a small specimen is, in proportion,

somewhat shorter. It is nearly allied to *Bulla? primæva*, Deslongchamps, 'Mém. Soc. Linn. de Normand.' t. 7., pl. x, figs. 23, 24; the latter is a larger shell, with the spire less exposed, and the aperture at the base much less lengthened and less pointed; it is therefore probably distinct. The elongation of the anterior part of the aperture appears also to separate it from *Acteonina convoluta*, Lyc., 'Cotteswold Hills,' p. 125, the left-hand figure, pl. iv. As three specimens of each form of different states of growth have been examined, we may rely upon the persistence of this distinctive feature.

Length 11 lines, opposite diameter 6 lines.

*Geological Position and Locality.* The Great Oolite of Kirklington, Oxon., collected by Mr. Whiteaves, who has obtained several specimens.

ACTEONINA LUIDII, *Luid.*, sp. Tab. XXXI, fig. 16.; Tab. XLI, fig. 18, *a, b, c.*

COCHLITES LUID. Lithoph. Brit. Ichnogr., 1699, 417.

ACTEONINA LUIDII, *Mor.* Cat. Brit. Foss., 1854, p. 234.

*Testa subcylindrica, antice mediocriter attenuato, postice truncato, anfractu ultimo superne angulato, lateribus planatis, spira depressa, anfractibus (4—5) angustis, apice exserto.*

Shell short, subcylindrical, moderately attenuated anteriorly, truncated abruptly posteriorly; volutions (4—5) depressed, narrow, their upper margins exposed upon the flattened posterior surface; the apex is slightly elevated and obtuse; the last volution has its posterior margin angulated and its sides flattened. Casts exhibit the upper margin of the last volution somewhat rounded, and also the edges of the other volutions.

Height one third greater than the transverse diameter.

*Geological Position and Localities.* The Forest Marble of Kidlington, Oxon., collected by Mr. Whiteaves, and of Cirencester, Gloucestershire, collected by myself, at both of which localities it is rare.

ACTEONINA CANALICULATA, *Lyc.* Tab. XXXI, figs. 9, 9 *a, 9 b.*

*Testa subcylindrica lævigata vel ovata, spira exserta, obtusa, anfractibus (7) angustis, subplanis, superne convexis, et canaliculatis, ultimo anfractu subcylindrico, basi . . . ?*

Shell subcylindrical, smooth, or ovate; spire elevated, obtuse, consisting of 7 narrow volutions, which have their sides flattened, their upper borders being rounded and deeply channeled; the last volution is nearly cylindrical, the aperture is not exposed, and the base is imperfect.

The characters of the spire, with its numerous narrow-channeled volutions, without angularity, appears to be sufficient to distinguish the species.

*Geological Position and Locality.* The Great Oolite of Kirklington, Oxon., obtained by Mr. Whiteaves.

*ACTEONINA SCARBURGENSIS, Lyc. Tab. XXXI, figs. 13, 13 a.*

*Testa ovata ventricosa lævigata, spira brevi obtusa, anfractibus (4) convexis, anfractu ultimo ad suturam subcanaliculato; apertura angustata, columella ad basin marginata.*

Shell ovately ventricose, smooth; spire short, obtuse, consisting of four narrow, convex volutions; the last volution has the sides slightly convex, its upper margin rounded and slightly channeled at the suture; the aperture is narrow, somewhat expanded at the base, which is margined at its junction with the columella.

A handsome ventricose shell, shorter and more tumid than *A. convoluta*, Lyc., which appears to approximate more nearly to it than other recognised species.

Length 14 lines, diameter of the last volution 10 lines, length of the aperture 11 lines. The specimen figured is from the fine collection of Mr. Leckenby; the test, which is thin, is partially preserved; it has a corneous aspect. A single specimen.

*Geological Position and Locality.* The Cornbrash of Scarborough.

*ACTEONINA SCALARIS, Lyc. Tab. XLIV, fig. 18.*

*Testa parva, subcylindracea, spira brevi, acuta, anfractibus 4, lateribus angustis planatis, marginibus acutis, superne tabulatis; apertura elongata, basi elliptico curvato.*

Shell small, subcylindrical; spire short, but elevated and acute, consisting of four narrow volutions, which are flattened upon their sides, their upper borders are acute, their upper areas are flattened; the aperture is moderately large and lengthened, its base is elliptically curved.

The length is 3 lines, the opposite diameter but little exceeds 1 line.

The upper angle of each volution is acute, and even slightly projects outwards, a character which is not seen in any other known species with an elevated spire. Possibly this is the young condition of a much larger species.

*Geological Position and Locality.* The Great Oolite of Kirklington, Oxon., collected by Mr. Whiteaves.

*DENTALIUM ENTALOIDES, Desl. Tab. XXXI, figs. 11, 11 a, 11 b.*

*DENTALIUM* ....., *Phillips*. Geol. York., i, pl. 4, fig. 37.

— *GLABELLUM, Bean*. Cornbrash Fossils, Mag. Nat. Hist., 1839, without figure or description.

— *ENTALOIDES, Deslongchamps*. 1842. Mém. Soc. Linn., vii, p. 128, tab. vii, figs. 36—38.

— — *D'Orb*. Prodrôme, i, p. 272, No. 205.

— *PARKINSONI, Quenstedt*. Handbook, t. 35, fig. 19.



DENTALIUM PARKINSONI, Quenst. Der Jura, p. 484, t. 65, figs. 5, 6.

— ENTALOIDES, Oppel. Die Juraformation, 1856-8, p. 390.

— ANNULATUM, Bean, Leckenby. Journ. Geol. Soc., 1858, vol. iv.

*Testa crassa, tereti, subarcuata, sæpius nitida, striis tenuissimis densissimis paululum obliquis ornata.* (Deslongchamps.)

Shell thick, tubular, round, smooth, shining, slightly curved; encircled with striations, which are somewhat oblique and strongly impressed towards the posterior or smaller extremity, anteriorly they are more faintly and densely arranged and ultimately disappear, the surface having some irregular annular folds of growth. Length of an imperfect Cornbrash specimen 24 lines, the larger diameter  $2\frac{1}{2}$  lines. The Calcareous Grit examples have larger dimensions, they are of more advanced growth, and have the greater portion of their cylinder devoid of striations.

The Cornbrash imperfect specimens are less slender and more straight than the figures of *D. Parkinsoni* given by Professor Quenstedt, and more nearly accord with those of *D. entaloides*, Deslongchamps; but the specimens figured by Quenstedt differ also from each other in their attenuation and curvature. *Dentalium cinctum*, Goldfuss, has encircling striations, without obliquity; *D. undulatum* of the same author has the figure somewhat compressed; *D. tenue*, Goldf., is more slender and more nearly cylindrical.

*Geological Position and Locality.* *Dentalium entaloides* appears to have a considerable geological range; the Cornbrash of Scarborough has produced a few specimens; Mr. Leckenby has also obtained it in the Kelloway Rock and the Calcareous grit of the same locality. *D. entaloides* was obtained by M. Deslongchamps in the Inferior Oolite of Moutiers and Bayeaux; by Dr. Oppel in the beds with *Ammonites Parkinsoni* at Mont d'Or, near Lyons; in Swabia it occurs at the upper boundary of the Lower Oolite (Braun Jura e. Quenst.) at Ehningen and Balingen.

TROCHUS STRIGOSUS, Lyc. Tab. XLV, fig. 12.

*Testa alta, conica, transversè costellatà, costellis granulosis æqualibus; anfractibus (5) subplanis, quadricostatis et vitta striata anteriora; ultimo anfractu obtusè carinatò; basi concava; columella obliqua; apertura sub-triangulari.*

Shell elevated, conical, transversely costellated; costellæ, four to a volution, granulated and equal; the anterior border of each volution has also a depressed, striated band; the volutions, about five in number, are flattened, and the last volution is rounded; the base has a few striations; the columella is oblique, and the aperture somewhat triangular.

The ornamentation is strongly marked and regular; the height and breadth are nearly equal; the sole specimen is rather imperfect at the apex.

*Geological Position and Locality.* The Cornbrash of Gristhorp Bay, near Scarborough, in the collection of Mr. Leckenby.

## BIVALVIA.

GRYPHÆA MINUTA, *Sow.* Tab. XL, fig. 30.

GRYPHÆA MINUTA, *Sowerby.* Min. Con., tab. 547, fig. 4.

— — *Morris.* Catal. Brit. Foss., p. 186.

*Testa parva, valva majora suborbiculata, umboni incurvo, lateré anticó sulcó breví instructó. Valva altera ignota.*

Shell small; the larger valve subglobose, suborbicular; the beak produced, incurved, and nearly straight, only slightly roughened by the area of attachment; the anterior side with a short sulcation, but no distinct lateral lobe. The smaller valve is unknown.

A minute Gryphæa, of which several specimens have been obtained by Mr. Witchell in the Minchinhampton Great Oolite; it has no well-defined distinctive features, and would scarcely have been deemed worthy of notice had it not been figured by Mr. Sowerby from Ancliff.

PLACUNOPSIS SEMISTRIATUS, *Bean, sp.* Tab. XXXIII, figs. 9, 9 a.

ANOMIA SEMISTRIATA, *Bean.* Mag. Nat. Hist., 1839, p. 61, fig. 21.

*Testa, valva majora convexa, subobliqua, ovato rotundata, apice submarginali, acutá, lamellis concentricis, irregularibus, superne lævigata, inferne lineis radiantibus subæqualibus nodulosis ornata. Valva affixa ignota.*

Shell with the larger valve ovate, slightly oblique, convex; the apex pointed, and placed near to the margin; the surface has numerous irregular, concentric lamellæ; the lower portion has numerous radiating lines, which are nearly equal, granulated, and undulated. The attached valve has not been obtained.

The test appears to be less delicate than is found in some other examples of the genus, and is usually affixed to another shell, more especially to *Terebratula lagenalis*, so that it is scarcely possible to obtain a specimen whose figure has not been affected by some extraneous body. The general aspect has much resemblance to *Placunopsis Jurensis* ('Gr. Ool. Monog. Biv.,' tab. i, fig. 13), but the latter has the ornamentation of the surface much more strongly defined, with larger and more densely arranged radiating lines. In *P. semistriatus* these can only be discerned with a magnifier.

*Geological Position and Locality.* The Cornbrash of the Yorkshire Coast, at Grinstead and Scarborough, where it is moderately rare. The upper portion of the Inferior Oolite in the Cotteswold Hills has a species probably identical with this *Placunopsis*, and possessing a similar kind of ornamentation.

## PECTEN RIGIDUS, Sow. Tab. XL, fig. 16.

PECTEN RIGIDUS, Sow. Min. Con., t. 205, fig. 8.

— — Morris. Catal., 1854, p. 177.

— — D'Orb. Prodr. Et., xi, p. 314.

— — Oppel. Juraformation, p. 492.

*Testa ovato-orbiculari, sub-æquivalvi, plano-convexa, reticulata, costis depressis, crebis, sub-regularibus, divergentibus, lamellis concentricis angustis, hinc inde decussatis; auriculis inæqualibus, transverse lamellosis, lamellis elevatis, crebris.*

Shell ovately orbicular, equivalve or subequivalve, moderately convex; costæ diverging, depressed, slightly unequal, sometimes undulating and closely arranged, crossed by narrow, irregular, concentric lamellæ, which are sometimes elevated upon the ribs, and in other instances form only narrow lines across the interstitial spaces, giving to them a punctated aspect; auricles large, unequal, with numerous transverse, narrow, elevated lamellæ.

*Geological Positions and Localities.* It is not uncommon in the upper portion of the Great Oolite, in the Forest Marble, and in the Cornbrash of many localities, as at Castle Combe; Stanton, near Chippenham; Kidlington, Oxon.; Rushden, Northamptonshire; Luc, France.

## PECTEN GRIESBACHI, Lyc. Tab. XXXIII, figs. 6, 6 a.

*Testa, valva sinistra crassa subæquilaterali acuta, compressa, auriculis magnis sub-æqualibus, radiatim costata et concentricè striatâ, costis (circa 26) superne angustis sub-æqualibus transverse striatis, inferne obsoletis; striis concentricis, regularibus tenuissimis; auriculis transverse plicatis. Valva altera compressa interne lævigata.*

Shell with the left valve thick, subequilateral, compressed, acute; auricles large, nearly equal, and transversely plicated; the surface is ornamented with about twenty-six very delicate, radiating costæ, which are striated, narrow, nearly equal, and regular; they are distinct towards the apex, but are only faintly traced towards the middle and lower part of the valve; the concentric striations are very fine and regular over the whole surface; a few faintly marked plications of growth are visible towards the lower border. The external surface of the right valve has not been exposed; its convexity is about equal to that of the other, its inner surface being smooth, without traces of the exterior ornamentation.

*Geological Position and Locality.* The Great Oolite of Wollaston, Northamptonshire, in the cabinet of the Rev. A. W. Griesbach.



PECTEN INÆQUICOSTATUS, *Phil.* Tab. XXXIII, figs. 1, 1 *a*.

PECTEN INÆQUICOSTATUS, *Phil.* Geol. York., i, pl. 4, fig. 10.

— — — *D'Orb.* Prodrome, p. 373.

— OCTOCOSTATUS, *Roemer.* Ool., p. 69, pl. 3, fig. 18.

— INÆQUICOSTATUS, *Mor.* Cat. Brit. Foss., 1854, p. 176.

— — — *Oppel.* Juraformation, p. 607.

*Testa ovato-acuta, convexa, longitudinaliter, 8 costata, concentrice lineata, costis convexis latis sulcis conformibus in dorso hinc inde dentatis, duobus mediis latioribus, lineis exilibus confertis sublamellosis auriculis subæqualibus longitudinaliter lineatis. (Roemer pro valva dextra.) Valva sinistra costis (8) angustis, elevatis rotundis asymmetricis, subnodosis, interstis latis irregulariter concentrice striatis.*

A convex, subæquivalve, acute-pointed Pecten, with large, nearly equal auricles; the surfaces of both the valves having irregular, concentric striations and several large folds of growth. The right valve has broad, slightly elevated costæ (8), which are unequal and slightly defined towards the posterior side, separated by narrow and but little depressed sulcations, which are distinct upon the inner surface of the valve; the left valve has eight narrow, elevated, but rounded costæ, of which those upon the sides are small and unsymmetrical; the intervening spaces are broad upon the middle of the valve, and very narrow laterally; the auricles are obliquely lineated.

*Geological Positions and Localities.* Rarely in the Cornbrash and Kelloway Rock of Scarborough, more commonly in the Coralline Oolite of Malton, but it is seldom well preserved at either of these geological positions; Roemer makes a similar statement respecting its occurrence at Lindner Berges.

PECTEN ARTICULATUS, *Schloth.* Tab. XXXIII, fig. 12.

PECTEN ARTICULATUS, *Schloth.* Petref., pp. 227, 228.

— — — *Goldf.* Petref., p. 47, tab. 90, fig. 10.

— — — *Roemer.* Verst., p. 68.

*Testa ovato-acuta convexa, costis angustis acutis, subæqualibus cingulatis acuminatis, sulcis duplo latioribus concavis subtilissime transversim striatis, auriculis inæqualibus lamelloso-lineatis costulisque virgatis. (Goldfuss.)*

Shell ovately pointed, convex; radiating costæ elevated, narrow, acute, more or less unequal, with acute transverse lamellæ; interstitial sulcations wider than the costæ, concave, with delicate transverse striations; auricles unequal, with radiating ribs crossed by lineal lamellæ. The more numerous ribs (about twenty-four), their irregularity and inequality, will distinguish it from *P. vimineus*, Sowerby, a species which abounds in the Inferior Oolite.

*Geological Positions and Localities.* *Pecten articulatus* occurs in the Cornbrash of the Yorkshire coast, and more frequently in the Calcareous Grit and Coralline Oolite of the same county.

PECTEN RUSHDENENSIS, *Lyc.* Tab. XXXIII, figs. 4, 4 a, 4 b, 4 c.

*Testa æquivalvi, suborbiculari, acuta, auriculis inæqualibus (auricula antica majora), valvis plano-convexis rugis concentricis elevatis, crebris, inferne squamatis, squamis brevibus, regularibus delicatissime instructis.*

Shell equivalve, suborbicular, acute, moderately convex; auricles unequal (the anterior one being the larger); the valves have a few plications of growth, and very densely arranged, elevated, concentric rugæ, which are slightly wrinkled towards the apices, but towards the middle of the valves become short, regular, scabrous elevations, disposed checker-wise with those above and beneath, so that when viewed obliquely the ornamentation resembles that of an engine-turned watch; this is more especially the case with the surface of the right valve, which has the concentric rugæ more delicate and closely arranged, and also the scabrous elevations; in other respects the valves are alike in the design of their ornamentation.

A beautiful suborbicular species; the minute scabrous elevations arrest the finger when it is passed upwards over the surface. It is very rare.

*Geological Position and Locality.* The Cornbrash of Rushden, Northamptonshire, in the collection of the Rev. A. W. Griesbach.

PECTEN WOLLASTONENSIS, *Lyc.* Tab. XXXIII, figs. 2, 2 a, 2 b, 2 c.

*Testa ovato-orbiculari compressa, æquivalvi, auriculis inæqualibus transverse plicatis et radiatim costatis; valva dextra concentrice striata et radiatim costata; striis tenuissimis, inferne lamelloso-rugosis; costis inæqualibus nodosis; numerosis, inferne evanescentibus; valva sinistra striis subtilissimis concentricis regularibus.*

Shell ovately orbicular, slightly convex, equivalve, with unequal auricles, the anterior one being the larger; they have numerous transverse plications and two or three radiating costæ; the surface of the right valve has concentric striations and radiating costæ; the striations are very fine and irregular; the middle and lower portion of the valve is occupied by irregular, scabrous, concentric plications; the radiating costæ are very numerous, irregular, and knotted; they gradually disappear towards the middle of the valve. The left valve has very delicate, regular, concentric, densely arranged striations.

This rare Pecten differs from *Pecten Dyonisius*, Buv., chiefly in being equivalve, and in the dissimilarity of the ornamentation in the opposite valves.

*Geological Position and Locality.* The Great Oolite of Wollaston, Northamptonshire, in the cabinet of the Rev. A. W. Griesbach.

PECTEN MICHELENSIS, *Buvignier*. Tab. XXXIII, fig. 3.

PECTEN CANCELLATUS, *Bean*, on Cornbrash Fossils, *Mag. Nat. Hist.*, 1839 (no figure or description).

— MICHELENSIS, *Buvignier*. *Paléont. de la Meuse*, Atlas, p. 24, pl. 32, fig. 7.

*Testa orbiculari, depressa maxima, concentrice rugosa et obsolete lineis subpunctatis irregulariter radiata, ad umbones costulis convexis, distantibus, regularibus radiantibus et concentricis decussata; umbonibus acutis; auriculis inæqualibus, transverse costellatis.* (*Buvignier*.)

Shell orbicular, depressed, large, rugose in the adult state, with slightly defined, irregular, radiating lines and large, irregular, concentric lamellæ; the umbones are acute, the auricles are unequal, the posterior auricle with large, rugose, transverse striations; the surface near to the umbo has regular, radiating costæ, slightly knotted where they are decussated by the concentric costæ, which are nearly regular, and somewhat less closely arranged than those which radiate.

The foregoing description applies to the right valve; the change which the surface undergoes in acquiring its adult condition is very striking, and is slightly indicated by the few last lamellæ upon the specimen figured; a very fine example in the Scarborough Museum, from the Coralline Oolite of Malton, shows that it ultimately acquired the aspect of Hinnites, thus losing all regularity in its ornamentation, and having very large, irregular, squamose lamellæ; the left valve has not been obtained.

*Pecten retiferus* ('Gr. Ool. Monogr. Biv.', p. 9, tab. i, fig. 15) approaches to it in the kind of ornamentation, but has the radiating costæ larger and more distant, as are also the concentric lamellæ; the umbones are less acute, and the auricles, which have a different figure, are more nearly equal. Under the name of *Pecten cancellatus*, it was inserted by Mr. Bean in his list of Cornbrash fossils, but without either figure or description. The splendid work of M. Buvignier on the 'Palæontology of the Meuse' exemplifies an aged specimen, together with the progressive changes which the ornamentation of the surface underwent.

*Geological Positions and Localities.* The specimen figured is from the Cornbrash of Scarborough; it occurs also in the Coralline Oolite of Malton; M. Buvignier has recorded it in the same formation at St. Mihiel and at Donaument.

PECTEN ANISOPLEURUS, *Buv.* Tab. XXXIII, figs. 5, 5 a.

PECTEN ANISOPLEURUS, *Buvignier*. *Paléont. de la Meuse*, Atlas, p. 23, pl. 19, figs. 31—35.

*Testa subrotunda, depressa, inæquivalvi; valva sinistra subplana, quinquecostata, lamellis concentricis, fibrosis, interdum interruptis, subtextis, ornata; costis distantibus, convexis,*



*squamatis, intervallis, triplolatoribus; costis extremis minoribus; auriculis subæqualibus, transverse lamellosis. Valva dextra convexiori quinq̄sulcata, concentricè tenuiter lamellosa; sulcis concavis, costis alteræ valvæ respondentibus; costis latioribus convexis, subdivisis.* (Buvignier.)

Shell suborbicular, inequivalve, depressed. The left valve nearly flat, with fine radiating ribs, separated by very wide intervals; the costæ have large, squamous plications, rather irregular, and nearly disappearing as they approach the apex, the costæ near to the margins being the smaller; the intervals between the costæ have five regular, concentric, squamous plications; the auricles are nearly equal, they are transversely lamellated. The right valve is convex, with five radiating sulcations, corresponding to the five costæ of the other valve; the whole surface of the valve is covered with delicate, regular, concentric, closely arranged lamellæ. The interior of the valves present an appearance corresponding with the ornamentation of the exterior.

Height rather greater than the breadth, and thrice the diameter through both the valves.

*Geological Position and Locality.* The Cornbrash of Scarborough and of Northamptonshire; the collections of Mr. Leckenby and of the Rev. A. W. Griesbach contain fine specimens. M. Buvignier quotes the species from the lower ferruginous beds of the Oxford Clay, Ardennes and Meuse.

HINNITES GRADUS, *Bean*, sp. Tab. XXXIII, figs. 10, 10 a.

PECTEN GRADUS, *Bean*. Mag. Nat. Hist., 1839.

*Testa valva sinistra, ovato orbiculari convexo-plana, radiatim undulato costata et concentricè lineata; umboni acuto submediano, auricula antico magno, oblique radiatim lineatis; auricula postica subnullo; costulis radiantibus numerosis, costa una majora et minora alternatim instructis, semel varicibus duobus radiantibus magnis. Lineis decussantibus densis regularibus; valva affixa ignota.*

Shell with the left valve ovately orbicular, somewhat convex, the surface irregular, with unequal, undulating, radiating costæ and concentric lines; umbo acute, mesial straight, the anterior auricle large, with oblique radiating lines, the posterior auricle scarcely produced; the surface of the valve has very numerous, unequal, radiating, rounded costæ, in two series, a larger and a smaller costæ being arranged alternately; there are also two elevated, irregular, large, radiating varices upon the middle of the valve, as in *Hinnites abjectus*. The costæ are about equal in width to the intercostal spaces; the entire surface of the shell has densely arranged, very regular, concentric lines, which are scarcely visible without the aid of a magnifier. The other valve is unknown.

Nearly allied, both in figure and aspect, to *Hinnites abjectus*, from which it is distinguished by the regularity and smoothness of the costæ and by the regular, concentric lines crossing both the costæ and the intercostal spaces; the latter are equal in width to the

costæ, whereas *H. abjectus* cannot be said to have any intercostal spaces, every part of the surface being occupied by unequal, crowded, nodose costæ; the two large, radiating, nodose, elevated varices are alike in both species.

The specimen figured is the original example, which belonged to Mr. Bean; it has lost a portion of the surface near to the lower border, and also a portion of the apex, nor will it appear remarkable that only a single specimen of a shell so thin and fragile should have been disengaged from a rock so intractable as the Cornbrash of Yorkshire.

*Geological Position and Locality.* The Cornbrash of Scarborough, in the collection of Mr. Leckenby.

AVICULA CIATHRATA, *Lyc.* Tab. XL, figs. 7, 7 a, 7 b.

*Testa parva suborbiculari, convexo-plana, valva sinistra auriculis subæqualibus magnis; superficie costis radiantibus (circa 24) acutis, regularibus et nodosis, lineis concentricis distantibus decussatis; valva altera subplana, lævigata, inornata.*

Shell small, suborbicular; the left valve with a low convexity, with large and nearly equal auricles; the surface of the valve has about twenty-four regular, acute, and slightly knotted radiating costæ, which are decussated by a few distantly arranged, concentric, elevated lines; the costæ radiate equally over the auricles and the middle of the shell. The right valve is more flattened, it is smooth and destitute of ornamentation. Diameter, about three lines.

*Geological Position and Locality.* The Great Oolite of Minchinhampton; a single specimen.

AVICULA SUBCOSTATA, *Roemer*, sp. Tab. XL, fig. 24.

MONOTIS SUBCOSTATA, *Roemer.* Nord. Ool., p. 75, t. 4, p. 7.

*Testa orbiculari subobliqua, convexa, longitudinaliter costulata, subtilissime concentricè striata, costulis (10—14) remotis superne evanescentibus, inæqualibus, auricula lævi, umbonibus minimis antrorsum incurvis. Valva sinistra. (Roemer.)*

Shell orbicular, rather oblique, convex, longitudinally costulated, and with very delicate concentric striations; costellæ (10—14) acute, distinct, rather unequal, and disappearing towards the umbo; auricles plain; umbo small, curved forwards. The right valve is not known.

A small shell; much less convex, less oblique, with a shorter hinge-line and more delicate ribs than *A. costata*, Sow.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common, at which place it is very rare.

GERVILLIA TORTUOSA, *Sow.*, sp. var. Tab. XL, fig. 25.

GASTROCHÆNA TORTUOSA, *Sow.* Min. Con., t. 526, fig. 1.

— — *Phil.* Geol. York., t. 11, fig. 36.

GERVILLIA TORTUOSA, *Mor.* Catal. Brit. Foss., 1854, p. 168.

— — *Oppel.* Juraformation, p. 418.

*Testa elongata, antice tortuosa, postice recto, attenuato, umboni perobliquo, subterminali; linea cardinis obliquissimo; margine antico undulato, plicis concentricis læviter instructis. Valva dextra subconcava, tortuosa; facies interna ignota.*

Shell elongated, convex, and contorted anteriorly, straight and attenuated posteriorly; umbo very oblique, with a small anterior auricle; hinge-border very oblique, anterior border undulated; the surface of the valve has five irregular, concentric plications upon its anterior side. The right valve is twisted conformably with the left valve; it is somewhat concave. The cardinal ligamentary pits have not been exposed in the present variety. Compared with the Inferior Oolite forms of *Gervillia tortuosa*, this variety is more narrow and less contorted, having the posterior extremity nearly straight; the umbo is also more acute, and the surface is destitute of the large, rugose, concentric plications which are conspicuous upon well-preserved examples of the typical form. So much variability, however, is seen in the contorted species of *Gervillia* that I prefer to regard the present as pertaining to *G. tortuosa*, but constituting a well-marked variety.

*Geological Position and Locality.* It occurs rarely in the Cornbrash of Scarborough; from the collection of Mr. Leckenby.

GERVILLIA ISLIPENSIS, *Lyc.* Tab. XL, fig. 35.

*Testa, valva sinistra crassa, obliqua, convexa, linea cardinis elongata, auricula postica permagna, falciformi, dorso angulo obtuso obliquo instructo; plicis incrementi paucis. Valva altera et foveolis interni ignotis.*

Shell with the left valve thick, inflated, very oblique, with a lengthened hinge-line and falciform posterior auricle; the anterior border is slightly excavated, and there is an obtuse, oblique angle, which extends from the umbo to the posterior extremity of the valve, which is curved backwards; the folds of growth are few and prominent; the surface is destitute of ornament. The other valve is not known, nor has the hinge been exposed.

The general figure much resembles that of *G. crassicosta*, *Mor.* and *Lyc.*, but it is more inflated; it has a greater posterior curvature, and is destitute of the oblique costæ. The length of our largest example is 2 inches, that of the hinge-line  $1\frac{1}{2}$  inch.

*Geological Position and Locality.* The Cornbrash of Islip, Oxon., also the Great Oolite of Stonesfield; collected by Mr. Whiteaves.



PERNA FOLIACEA, *Lyc.* Tab. XXXVII, figs. 3, 3 *a*.

*Testa ampla subæquivalvi, subplana, umbonibus prominulis acutis; latere antico excavato, margine posteriore et inferiori elliptico curvato; lateribus rugis concentricis paucis irregularibus. Foveolis interni ignotis.*

A large, subæquivalve, depressed shell, with prominent, pointed umbones, excavated and thickened anterior border, the hinge-line short, the posterior and inferior borders elliptically rounded, the general figure being mytelliiform, the left valve being somewhat more convex than the other; the test is thin, with delicate margins.

*Dimensions.* Length,  $4\frac{1}{2}$  inches; opposite diameter,  $2\frac{1}{2}$  inches; the hinge-area has not been exposed.

*Geological Position and Locality.* The Great Oolite of Minchinhampton Common; a single fine specimen of each valve is in the collection of the author, who is not cognizant of any other examples.

INOCERAMUS QUADRATUS, *Sow.*, sp. Tab. XXXVIII, figs. 1, 1 *a*, 1 *b*.

PERNA QUADRATA, *Sow.* Min. Con., t. 492, non Phil. non Goldf.

— — *Lycett.* Ann. and Mag. Nat. Hist., 1855.

*Testa tenue subquadrata, transversa, inæquivalvi, valde inæquilatera, valva sinistra antice oblique inflato, postice compresso; umboni magno, subinvolute, antrorsum instructo; linea cardinali subhorizontali elongato; latere anteriore truncato, infra umbonem concavo, basi subrecto, superficie rugis concentricis paucis irregularibus. Valva dextra planata umboni parvo antico. Foveolis interni parvis numerosis.*

Shell thin, subquadrata, transverse, inequivalve. The left valve inflated anteriorly, with a large, subinvolute, projecting beak, and a steep, truncated and excavated slope beneath it; the posterior side is very thin, compressed, and expanded; the hinge-line is lengthened and nearly horizontal; the base is lengthened and nearly straight. The right valve is flattened; the umbo is small, pointed, and anterior. The internal hinge-pits are placed upon a narrow, lengthened plate; they are small and numerous. The surfaces of the valves are smooth, with a few irregular, concentric plications.

The diagnosis in the 'Mineral Conchology' is as follows:—"Quadrilateral, one side shorter than the other three; valves gibbose, unequal, the shorter side very concave, bounded by two obtuse carinæ."

The figure in the 'Mineral Conchology' has the right or smaller valve facing the spectator; the contour of the larger or convex valve is not seen; even the outline is not perfect, as there seems to be a portion of the lower (right) border wanting, and thus forming an angle at its anterior extremity, which would be rounded in the perfect shell; but the whole is stated by the author to be little better than a cast. With such an

illustration it is not surprising to find that in the plates to the 'Geology of Yorkshire,' and in the 'Petrefacta' of Goldfuss, two very different species of *Perna* (flattened, equivalve, and rugose) were figured for the *Perna quadrata* of Sowerby.

The convexity of the left valve, little remarkable in young specimens, becomes very considerable with advance of growth; the test upon the anterior side is moderately thick, but the posterior side is delicate and is rarely preserved entire. Upon the smaller of the specimens figured the portion denuded of the test exhibits obscure, concentric, and radiating striations in the convex valve; the same feature is also visible upon the surface of the cast of the smaller valve figured by Mr. Sowerby; it must therefore have existed upon the inner surface of the very thin, nacreous layer of the test, which has not been preserved; the exterior surface of the test is quite destitute of ornamentation.

*Dimensions.* Length of our largest specimen, in the direction of the hinge-line,  $5\frac{1}{4}$  inches; height,  $3\frac{3}{4}$  inches; convexity of the larger valve,  $2\frac{1}{4}$  inches.

*Geological Positions and Localities.* Mr. Sowerby's specimen was obtained in the Cornbrash at Bulwick, Northamptonshire, and, as far as can be ascertained, no second example has been obtained from that locality. In the Inferior Oolite of the vicinity of Nailsworth the present author has procured specimens at several quarries, in a single bed; its position being the highest bed of the white building-freestone, and immediately underlying the bed of hard, cream-coloured limestone with *Nerinaeas*, which appears to be special to the Nailsworth valley. *Perna quadrata* does not appear to be very uncommon; but owing to the thinness of the fibrous test, it can only be disengaged from the Oolite by a tedious and difficult process; more frequently, however, the shell is found to have been crushed or imperfectly preserved at its posterior side.

LIMA PECTINIFORMIS, *Schloth.* Tab. XXXVI, fig. 1. Part II, Tab. VI, fig. 9. <sup>1</sup>

In figuring a larger and more characteristic example of this shell some additional remarks may be allowed. It is widely diffused, abundant and of large dimensions in the upper portion of the Inferior Oolite, rare and delicate in the Great Oolite, rare in the Cornbrash, in the Kelloway Rock and Oxford Clay; it reappears in considerable numbers in the Coralline Oolite, assuming all its pristine varieties of form; these are sufficiently remarkable. In its young condition it was gregarious, and probably was attached by one of the valves to the ground; such, at least, seems an easy explanation of the fact that the upper surface of a slab of stone covered with the species usually discloses only the inner surfaces of single valves, the other valves having probably been removed by marine action in their dead state; but although young and thin, the specimens in this condition often attained to the full dimensions of the species, the radiating flutings of the external surface being almost equally strongly marked upon the inner surfaces, in which state, also, the muscular scar is not distinguishable, and when the valves are closed the umbones touch each other. In old specimens, owing to a continual deposition of shell upon the inner



surface, more especially towards the umbones, the triangular sub-umbonal area is large and oblique, so that the umbones then are widely divergent; the internal radiating flutings have gradually disappeared, or are only visible at the lower border of the valves; the muscular scar is conspicuous; ultimately, each valve acquired at its umbonal extremity a thickness of two inches and a half, the cavity of the interior became much smaller, the outer surface ceased to be extended at its borders during this internal accretion of shell; we may also infer, from its solid, ponderous mass, and from the frequency with which it became perforated by the Lithophagidæ, that, unlike the common Limæ and Pectens, its habits were sedentary; doubtless these perforations may have been made in dead shells, but they are not to be discovered in any other of the Jurassic Limæ.

The test consists of two very distinct layers; the outer layer is always thin and semi-transparent, the inner layer is white, opaque, laminated, and received continual additions to its thickness; in brief, the structure and mode of growth agrees with that of the genus *Spondylus* as fully as does the external aspect of the imbricated rugæ and the tubular, spine-like processes; it is, in truth, *an equivalve Spondylus, destitute of hinge-teeth*. The variations of figure are also considerable; sometimes sub-orbicular, with no more obliquity than a *Pecten* or *Spondylus*, with the sides nearly equal, the radiating costæ undulating and irregular, as in *Hinnites*; in other instances it is oblique, with a steep anterior slope; add to this latter figure a greater lengthening of the valves, a compression of the posterior side, and the aspect becomes strictly that of *Lima*, as in *L. squammicosta*, Buv., which appears to be only the young condition of this variety.

Few shells differ more in the convexity of the valves; occasionally an example will be found so much inflated that its figure can only have resulted from having been moulded upon and remained closely adherent to a convex surface, to which the missing valve probably remained attached.

The shell is not inæquivalve, although such an appearance is often imparted to it from a depression, or an irregularity in the convexity of one of the valves; as, however, the borders of the valves are found to fit perfectly, this distortion cannot be owing to the effects of fossilization.

Even from the earlier days of palæontology this shell has been a source of doubt and perplexity. Schlotheim referred it to *Ostracites*, as also did Ziethen. Mr. Sowerby, in the 'Mineral Conchology,' placed it with *Lima*, but expressed doubts as to the genus; more recently, Professor Quenstedt, in his 'Jura,' after alluding to the features which distinguish it from the ordinary Limæ, divides it into two varieties, one having a thick and the other a thin shell; he concludes by assigning it to the genus *Ostrea*, but without offering any proofs that it would be correctly placed with the latter genus. The change from the thin to the thick shell has already been explained, and the structure of the test is distinct from that of *Ostrea*.

*Lima pectiniformis* may be placed at the head of a group of Jurassic Limæ which are nearly allied, both in their external characters, shell structure, and mode of growth; these



are the following: *L. Elea*, D'Orb., from the Supraliasic Sands; *L. Electra*, D'Orb., from the Supraliasic Sands and the Inferior Oolite; *L. Hector*, D'Orb., Inferior Oolite; *L. Luciensis*, D'Orb., Great Oolite; *L. rudis*, Sow., Coralline Oolite; *L. rotundata*, Buv., Coralline Oolite; *L. angusta*, Buv., Coralline Oolite.

LIMA PUNCTATILLA, *Lyc.* Tab. XL, fig. 32.

LIMA PUNCTATILLA, *Lyc.* Ann. and Mag. Nat. Hist., 1853, p. 420.

*Testa parva, inflata, ovato-oblonga, auriculis parvis subæqualibus, lateribus leviter excavatis; costis radiantibus (circa 24) elevatis, granulatis, interstitiis angustis, striis concentricis crebris decussatis.*

Shell small, inflated, ovately oblong; auricles small and nearly equal, the sides of the valves steep and slightly excavated; radiating (costæ about 24), elevated, granulated; large upon the centre of the valves, and degenerating upon the sides into lines, decussated by closely arranged concentric striations.

The general figure resembles *Lima gibbosa*, but more convex, and with radiating lines or delicate costæ upon the sides, which increase in size symmetrically towards the middle of the valve, each rib being ornamented with a minute line of granules. The specimen figured is of less dimensions than others, but it has only occurred very rarely.

*Geological Position and Locality.* The Great Oolite of Minchinhampton; the Inferior Oolite of Leckhampton Hill, in the shelly freestone.

LIMA HELVETICA, *Oppel.* Tab. XXXIII, figs. 8, 8 a.

LIMA GIBBOSA, *Goldfuss.* Pet., t. 102, fig. 10, p. 86, non Sow.

— HELVETICA, *Oppel.* Juraformation, p. 489.

*Lima testa fornicata ovata subobliqua antice declivi, costis (25—27) subacutis adpressis et linea laterali notatis, sulcis conformibus, lunula lævi convexa.* (Goldfuss.)

Shell ovately oblong, convex, slightly oblique; anterior slope lengthened, steep; posterior slope more gradual and flattened; umbones acute, straight; anterior and posterior auricles equal and but little produced, forming a short horizontal hinge-line; radiating costæ upon the middle portion of the valves narrow, sub-acute, 25—27 in number at the lower border, 14—15 near to the umbo, the additional costæ near to the lower border consisting of smaller intervening costæ or lines, unequal in size, and rather irregularly arranged; the larger costæ towards the sides of the valves appear as if compressed upon the shell. The anterior sides of the valves are nearly smooth, but each side has a few very delicate radiating lines; the entire surface of the valves has very delicate, closely arranged, concentric, irregular striations, which impress the costæ, and are very conspicuous upon the wide, flattened intercostal spaces; the valves are close fitting and thin.

*Geological Position and Localities.* It occurs rarely in the Cornbrash of Scarborough. Dr. Oppel records it in the same geological position at Marquise, near Boulogne; also at Egg, near Aarau, Switzerland. Goldfuss records it at the latter locality, and at Basel.

LIMA RIGIDULA, *Phil.*, sp. Tab. XXXIII, figs. 7, 7 *a*.

PLAGIOSTOMA RIGIDULUM, *Phil.* Geol. York., i. t. 7, fig. 13.

*Testa elongata, convexa, per-obliqua, umbonibus obliquis, acutis, auriculis parvis sub-æqualibus; latere antico elevato, excavato, postico elliptico curvato; valvis costulis radiantibus angustis, rotundatis, regularibus, sed undulatis et granulatis; interstis duplo latioribus subtilissime transversè striatis, striisque regularibus instructis.*

Shell elongated, convex, very oblique; umbones small, pointed anterior; auricles small, nearly equal; anterior side very convex, with a steep, excavated border; posterior side curved elliptically; the entire surface has delicate but rounded, elevated, and finely knotted radiating costæ, gently waved and separated by interstitial spaces twice the breadth of the costæ; the spaces have very fine, regular, and closely arranged transverse striations; the plications of growth are few, but become prominent near to the lower border.

One of the most elongated and oblique of the Jurassic Limæ. The general figure and ornamentation would much resemble *Lima ovalis*, Sow., if the convexity of the anterior side were not much greater, and the costæ more elevated, in the Cornbrash shell; the striations are so densely arranged that the spaces do not present a punctated aspect, as is usually seen when the striations are more distant, and larger.

*Dimensions.* Length, 20 lines; breadth, 12 lines; diameter through both the valves, 10 lines.

*Geological Position and Locality.* The Cornbrash of Scarborough, in which it is abundant.

MODIOLA GIBBOSA, *Sow.* Tab. XXXIII, figs. 11, 11 *a*.

MODIOLA GIBBOSA, *Sow.* Min. Con., t. 211, fig. 2.

— RENIFORMIS, *Sow.* Ib. fig. 3. ?

— — *D'Orb.* Prodr., i, p. 282.

— GIBBOSA, *Mor.* Catal., 1854, p. 210.

*Testa elongato-ovato, convexa subreniformi umbonibus curvatis acutis sulco obliquo antico; latere antico inferne sinuato, latere postico elliptico curvato; lateribus plicis magnis concentricis distantibus.*

Shell ovately elongated, very convex; umbones pointed, curved forwards; an oblique sulcation proceeds downwards and forwards to the lower part of the anterior border, which



is sinuated; the anterior side has a large, rounded, but compressed lobe; the posterior border is very convex, and is curved elliptically; the surfaces of the valves have a few large, irregular and distant plications.

The length is twice the breadth, and two fifths greater than the convexity of the united valves.

The very inflated figure, the curvature of the valves, and the distinct anterior broad sulcation, distinguishes it from other Jurassic species; some specimens, smaller and apparently younger, cannot perhaps be distinguished from *Modiola reniformis*, Sow., for the species varies in the length, curvature, and convexity.

*Geological Positions and Localities.* This species is figured upon the authority of specimens in the Museum of Practical Geology, which are stated to have been collected in the Cornbrash of Melbury Osmond. It is common in the Inferior Oolite of the southern counties.

CUCULLÆA CORALLINA. Tab. XXXIX, fig. 3.

CUCULLÆA OBLONGA, *Phil.* Geol. York., i, t. 3, fig. 34, non Sow.

— CORALLINA, *Damon.* Geol. Weymouth, Suppl., pl. 4, fig. 8.

*Testa inflata, subrhomboidali, subæquilaterali, umbonibus magnis medianis acutis, incurvis, latere postico abbreviato abrupte truncato, area cardinis brevi, superficie lineis longitudinalibus crebris, irregularibus aliis radiantibus subobsoletis decussata.*

Shell much inflated, subrhomboidal, nearly equilateral; umbones large, mesial, incurved, elevated, slightly oblique, and nearly in contact.

The anterior side is produced and rounded, the posterior side is very short, abruptly truncated, slightly excavated, and separated from the other portion of the surface by a strongly defined subacute angle; the hinge area is short and not wide; the surface has densely arranged, irregular, longitudinal lines, decussated by others radiating, but much less clearly defined.

*Dimensions.*—Height, three fourths of the length.

A very short, tumid, abruptly truncated Cucullæa, possessing these characters in a greater degree, and less oblique than any of the shorter examples of *C. oblonga*, Sow.; the latter shell has also several large, widely separated, radiating lines upon the anterior side, of which our species is destitute. It appears to be identical with *Cucullæa oblonga*, Phil., from the Coral Rag, at least with the more short examples of that species, for the Coral Rag shell presents great variability in its general figure, more especially in that of the posterior side, and it is easy to obtain specimens which insensibly connect the shorter with the more lengthened and oblique forms; it rarely happens that the surface ornamentation can be discovered, but the portions of the surface obtained agree with that of the Cornbrash shell.

*Geological Positions and Localities.* *Cucullæa corallina* occurs rarely in the Cornbrash of the Yorkshire coast, but is abundant in the Coral Rag of Pickering and of Oxfordshire.



*CUCULLÆA CLATHRATA*, Leck. Tab. XXXIX, figs. 4, 4 a.

*CUCULLÆA CLATHRATA*, Leckenby. Journ. Geol. Soc., 1858, vol. xv, pl. 3, fig. 4.

*Testa subrhomboidali inflata, umbonibus antemedianis magnis, valde separatis, area ampla, excavata, lanceolata, basi subrecto; valvis rugis longitudinalibus, irregularibus, lineisque radiantibus, crebris tenuibus, dorso angulo obtuso et obliquo.*

Shell subrhomboidal, inflated; umbones large, placed anterior to the middle of the valves, separated by a large lanceolate area; there is an oblique obtuse angle upon the posterior side, separating a concave posterior space from the middle portion of the valves; the surface has large, longitudinal, irregular, rugose plications crossed by closely arranged, delicate, radiating lines; the lower border is nearly straight, and slightly sinuated.

The shorter posterior side and larger umbones distinguish it from *Arca lata*, Dunker, to which in other respects it has a considerable resemblance.

*Dimensions*.—Length, 26 lines; height, 14 lines; diameter through both the valves, 16 lines; space separating the points of the umbones, 3 lines.

*Geological Position and Locality*. The Cornbrash of Scarborough, also in the Kelloway Rock of the same locality. In the collection of Mr. Leckenby.

*NUCULA MENKEI*, Roem. Tab. XXXIX, fig. 2.

*NUCULA MENKEI*, Roemer. Nordd. Ool., t. 6, fig. 10, p. 98.

*Testa ovata, medio ventricosa concentricè striata, antice brevissima acuta oblique truncata, cordato-subexcavata, posterius producta rotundata, basi subarcuata, umbonibus crassis incurvis, aream lanceolatam haud efformantibus.* (Roemer.)

Shell ovate, anterior side very short, somewhat excavated, and pointed at its lower extremity; posterior border lengthened, curved, sloping obliquely downwards, its lower extremity rounded, base slightly curved elliptically, umbones large, incurved, area very slightly defined; the middle portion of the valves is moderately convex, with a few distant plications of growth, and delicate concentric striations obscurely defined.

*Nucula variabilis*, Sow., approximates to this species, but is without the anterior excavation, and has a more lengthened posterior side. *Nucula nuclens*, Desl., is shorter and more globose.

*Geological Positions and Localities*. Roemer records *Nucula Menkei* in the Portland Limestone of Wendhausen. Mr. Whiteaves has collected it in the Great Oolite of Kirklington, and in the Cornbrash of Islip, Oxon.

*Genus*—ISOARCA, *Munster*.

Shell equivalve, ventricose ; umbones large, anterior or antero-mesial, sometimes more or less spiral, ligament external ; hinge-border lengthened, curved, with two series of small transverse teeth, which decrease in size towards the centre ; pallial impression simple.

ISOARCA SCARBURGENSIS, *Lyc.* Tab. XXXIX, figs. 5, 5 a.

*Testa tenui, ovato-oblonga, tumida, umbonibus magnis subanticis, prominentibus, latere antico brevi, curvato, postico elongato, oblique declivi, sulcis duobus evanescentibus ; margine inferiore subrecto ; valvis striis concentricis irregularibus, inferne semel granulis irregularibus instructis.*

Shell thin, ovately oblong, somewhat inflated ; umbones large, prominent, placed anterior to the middle of the valves, directed obliquely forwards ; anterior side short and curved elliptically, posterior side lengthened, the margin sloping obliquely downwards with two slightly impressed oblique furrows, which are distinct towards the umbo ; the lower border is lengthened and nearly straight ; the surface has fine irregular, concentric striations, and the sides have towards their lower border irregular, rounded granules, rather distantly arranged.

*Dimensions*.—Length, 24 lines ; height, 16 lines ; diameter through the valves, 12 lines.

A fine and rare example of a genus which seldom occurs in the Jurassic rocks of this country. It is much less inflated, and the umbones are more prominent than in *Isocardia transversa*, Munst., less oblong, and with the anterior side more produced than in *Isoarca Lochensis*, Quenst., and *Isoarca eminens*, Quenst. Other Jurassic species more remotely allied and approaching the orbicular figure are *Isoarca subspirata*, Munst., *Isoarca texata*, Munst., *Isoarca decussata*, Munst., and *Isoarca cordiformis*, Quenst. The general figure resembles Cypricardia, but when the hinge cannot be exposed, the genus may be distinguished by the granulations upon the surface, and by the tenuity of the test.

*Geological Position and Locality*. The Cornbrash of Scarborough, in the collection of Mr. Leckenby.

LEDA ANGLICA, *D'Orb.* Tab. XXXIX, fig. 7.

NUCULA LACHRYMA (obtuse variety) *Phil.* Geol. York., i, pl. 9, fig. 25.

LEDA ANGLICA, *D'Orb.* Prodr., p. 275.

*Testa lævigata parva, inflata, subtrigona, umbonibus medianis obtusis incurvis depressis, latere antico curvato, oblique-declivi, latere postico abrupte declivi, acute carinata, carina obliqua promimula ; valvis striis longitudinalibus obscuris et plicis incrementi paucis impressis.*



Shell small, inflated, short, subtrigonal; umbones depressed, mesial, obtuse and incurved; the anterior border is rounded, sloping downwards and uniting with elliptical curvature of the lower border; the posterior side slopes abruptly downwards, it has an oblique posterior carina, which becomes conspicuous and raised towards its lower extremity; it separates a posterior, depressed, lanceolate area from the sides of the shell. The surface has obscure longitudinal striations, and several folds of growth.

The inflated figure, short posterior side and projecting oblique posterior carina, distinguish it from *Leda lachryma*, Sow., and also from other species of the Lower Oolites.

*Geological Positions and Localities.* The Cornbrash of Scarborough, in which it occurs rarely. Professor Phillips records it in the lower stage of the Inferior Oolite (Dogger), and in the gray limestone or upper stage of the same formation upon the coast of Yorkshire.

TRIGONIA ELONGATA, Sow. Tab. XXXIX, figs. 6, 6 a.

TRIGONIA ELONGATA, Sow. Min. Con., t. 431.

—	—	<i>D'Orb.</i>	Prodr., vol. i, p. 338.
—	—	<i>Morris.</i>	Catal., 1854, p. 228.
—	—	<i>Oppel.</i>	Juraformation, p. 525.
—	—	<i>Damon.</i>	Geol. Weymouth, Suppl., pl. 2, figs. 1, 2.

*Testa subtrigona, alta, convexa, antici brevissima truncata, costis, magnis, subhorizontalibus, leviter undulatis; umbonibus prominentibus acutis incurvis; area cardinali lata, ornatissima, distincte tripartita, carinis prominentibus, denticulatis.*

Shell subtrigonal, very convex and lengthened; anterior side short, its border abruptly truncated with numerous large, nearly horizontal and slightly undulated costæ; the umbones are elevated and much incurved; the posterior area (which nearly equals in size the other portion of the surface) is very wide, and is separated into three distinct parts by as many prominent denticulated carinæ; the marginal carina is very large and nearly straight; the mesial and inner carinæ though smaller are likewise conspicuous in both the valves; the space between the mesial and inner carina is much depressed and its ornamentation is very delicate; the superior or post ligamental space is short and wide, it has a few elevated perpendicular plications. The convexity of the united valves is somewhat greater than the breadth of the shell, and equal to two thirds of the length of the marginal carina.

The general figure and other characters are so strongly defined that it will not readily be mistaken for any other example of the group of the *Costatæ*; the figure of the Cornbrash specimens agrees with those from the Oxford Clay, but the sculpture upon the area is less strongly marked in specimens from the latter formation, which are also usually smaller. Compared with other examples of the same group of species, *T. elongata* is remarkable for the short, widely-separated horizontal costæ, for the great size and straightness of the



marginal carina, for the prominence of the sculpture upon the tripartite area, and more especially for the shortness and great breadth of the superior or post-ligamental space, which, when the valves are united, becomes cordate rather than lanceolate. D'Orbigny (Prodrome) believes it to be identical with *T. cardissa*, Agassiz, it is, however, only necessary to compare the marginal carina in the two forms to perceive their distinctness.

*Geological Positions and Localities.* It is abundant in the Oxford Clay of the southern counties, more especially at Radipole near Weymouth, and in the Cornbrash of the coast of Yorkshire, at Gristhorp, and at Scarborough. The foreign localities cited are France, Dives, Villers (Calvados), Clucy, Mont Orient, near to Salins (Jura), Montsec, near to St. Mihiel (Meuse), Marault, near to Chaumont (H. Marne), Beaumont, Pizieux, Chauffour (Sarthe).

TRIGONIA TUBERCULOSA, *Lyc.* Tab. XL, fig. 6.

TRIGONIA TUBERCULOSA, *Lycett.* Ann. and Mag. Nat. Hist., 1850, p. 12, t. 11, fig. 9.

— — *Morris.* Cat. Brit. Foss., 1854, p. 229.

*Testa ovato-trigona, subdepressa, umbonibus parvis, recurvatis, marginè anteriore et inferiore rotundo, marginè postico excavato, area angustata, transverse plicata, plicis magnis acutis; carina marginali delicati nodulois; carina interna varicibus magnis regularibus ornata; area lanceolata varicibus paucis obliquis; valvis lateribus costis numerosis concentricis et dense tuberculosus, tuberculis crebris elevatis, compressis.*

Shell ovately trigonal, depressed; umbones small, mesial and recurved, anterior and lower borders rounded, superior border rather excavated; area narrow, with two oblique carinae, and with transverse acute plications, every second plication forming a varix upon the inner carina; the marginal carina is delicately tuberculated; the post ligamental lanceolate space is small, with several oblique varices; the sides of the valves have very numerous, closely arranged, concentric tuberculated, costa; the tubercles are much elevated, and compressed laterally, imparting to them a club-shaped figure, the lower extremity of each extending to the succeeding costa.

A pretty little species, remarkable for the delicacy and salient features of its ornamentation. The characters of the tubercles upon the sides of the valves closely resemble those in *Trigonia elathrata* Ag., but in other particulars the two species are widely separated; the close contiguity of the extremities of the tubercles between row and row gives to them, when viewed from the posterior side, the appearance of forming a series of vertical costae; the tubercles are, however, very well separated in the rows, and towards the lower border they project considerably from the sides of the valves; eighteen rows of costae may be counted in a specimen whose length is only nine lines.

*Geological Positions and Localities.* The specimen figured is from the cabinet of the Rev. A. W. Griesbach, and was obtained by him from the Cornbrash of Rushden; it

is silicified, and is a beautiful object for the delicacy of its ornamentation; the original specimen figured by me in the 'Annals and Magazine of Natural History,' was obtained by the Rev. P. B. Brodie in the shelly freestone of the Inferior Oolite at Leckhampton Hill; at each locality it ranks as one of the more rare productions.

TRIGONIA CLYTHIA, *D'Orbigny*. Tab. XXXVII, fig. 2; Tab. XL, figs. 5, 5 a.

TRIGONIA CLYTHIA, *D'Orbigny*. Prodr. de Paléont., i, p. 309.

*"Coquille singulière par ses côtes concentriques formant de deux en deux un angle sur la région anale, indépendamment de la area costulée en travers."* (*D'Orbigny*.)

*Testa subtrigona, convexa, transversim costata, costis numerosis, crebris, curvatis, postice alternatim angulatis, carina marginali lævigato, elevato, areâ planatâ transversim costatâ, costis magnis, depressis.*

Shell subtrigonal, convex, transversely costated; costæ numerous, small, closely arranged, curved, convex upon their lower and concave upon their upper sides; the first few costæ are united to the marginal carina, the succeeding costæ are bent suddenly upwards at their posterior extremities, forming a series of angles, one of which proceeds from every second costa; the marginal and inner carinæ are smooth and elevated; the area is moderately wide, flattened, traversed transversely by a few large depressed and waved costæ, which are interrupted by an oblique mesial furrow.

The general figure is nearly triangular; the umbones are mesial, much elevated and pointed; the anterior border is nearly straight, sloping obliquely downwards, but slightly sinuated immediately beneath the umbones; the posterior border is short and oblique.

*Dimensions*.—The height and the lateral diameter are nearly equal; the diameter through both the valves is one fifth less.

The costæ upon the sides of the valves are so closely arranged that about twenty occur in a specimen seven lines in height.

*Geological Positions and Localities*. The Great Oolite of Minchinhampton and Bisley Commons, also in the upper zone of the same formation near to Bath. Luc (Calvados).

TRIGONIA SCARBURGENSIS, *Lyc*. Tab. XXXVII, fig. 1.

*Testa ovato-trigona subdepressa, elongata, umbonibus recurvatis, margine antico rotundo, postico excavato, producto; area angusta, elongata, carinis tribus delicatissimis ornato; valvis costis tuberculatis, magnis per series leviter arcuatis, antice parvis, irregularibus, postice magnis curvatis.*

Shell ovately trigonal, rather depressed, elongated; umbones recurved; anterior side rounded and produced; posterior slope somewhat concave, lengthened; the area is narrow, flattened, with irregular transverse striations, and ornamented with three very delicate



knotted carinæ, the lanceolate, post-ligamental space is much lengthened, smooth, and excavated. The costated portion of the shell has the rows at first regular and concentric, with regular, distinct tubercles; subsequently the costæ become more ridge-like and the tubercles less separated; anteriorly they are small, and the rows are broken and confused; posteriorly they are large and more regular, curving upwards slightly, but their extremities are well separated from the marginal carina.

This is the shell attributed by Messrs. Young and Bird to *T. clavellata*, and subsequently also by Professor Phillips, Professor Williamson, and Mr. Bean, in their lists of Cornbrash fossils.

*Trigonia signata*, Ag., figured in the second part of the Great Oolite Monograph under the name of *Trigonia decorata*, is also an elongated shell, but is destitute of the recurvature of the umbones and of the produced anterior side; the rows of costæ likewise differ; the posterior portions are not larger than the anterior, and there is wanting that arrest in the continuity of the rows always conspicuous in the Cornbrash shell, and which imparts to the anterior portion of the latter form a broken, irregular character. *Trigonia clavellata*, Lhwyd, Parkinson, and Sowerby, so abundant in the Lower Calcareous Grit of England, France, and Switzerland, has a much shorter and more convex figure, the umbones are not recurved, features which will suffice to distinguish them irrespective of the ornamentation of the surface. *T. perlata*, Ag., and *T. Bronnii*, Ag., from the same beds, appear to be only varieties of *T. clavellata*. *Trigonia Scarburgensis* is also allied to that beautiful and well-known Oxford Clay representative of the *Clavellata* so long procured at Weymouth, and of which a good figure is given in Mr. Damon's 'Geology of Weymouth,' Suppl., pl. ii, fig. 3; the latter, in addition to the unusual elongation of its posterior side, has a wide diagonal space, destitute of ornament, separating the posterior extremities of the costæ from the marginal carina.

*Geological Position and Locality.* *Trigonia Scarburgensis* is moderately common in the Cornbrash of the Yorkshire coast; it may also occur in the same rock of the southern counties, but the condition of the specimens is such that it has not been ascertained with any confidence.

TRIGONIA CASSIOPE, *D'Orb.* Tab. XXXVII, fig. 10.

TRIGONIA CASSIOPE, *D'Orb.* Prodrome de Paléont., 1, p. 308.

*Testa ovato-trigona, transversè elongata, subdepressa, costis transversis, subhorizontalibus, numerosis, lævigatis, gracilibus curvatis, antice rotundata, postice producta; area tricarinata, carina marginali et interna crenulata, carina mediana parva; carinarum intervallo costellis longitudinalibus granosis, confertis, ornatis; area postica lanceolata, delicatè reticulata.*

Shell ovately trigonal, transversely elongated, somewhat depressed; transverse costæ



numerous, smooth, slender, nearly horizontal, and gracefully curved; the anterior border is rounded; the area is lengthened, narrow, and slightly excavated, having three carinæ, of which the marginal and inner carinæ are conspicuous, curved, and crenulated; the median carina is small; the spaces between the carinæ have longitudinal, delicate, closely arranged, granulated little costæ; the post-ligamental lanceolate space has a very delicately reticulated surface.

A transversely lengthened, large, and gracefully curved form, much less convex than *T. costata*, with more depressed umbones, and having the anterior side greatly more rounded and produced. The costated portion of the shell is very large; the costæ are numerous, not much elevated; their direction is nearly horizontal, excepting near to the apex, where they have an elegant sigmoidal curvature. The length upon the marginal carinæ is one fourth greater than the opposite measurement; the diameter through both the valves is somewhat less than half the height. The area is very narrow and lengthened, the ornamentation of its surface is minute and delicately sculptured, the general figure is depressed, which, together with the small prominence of the umbones, the excavated posterior side, and the large, rounded anterior side, will, in the aggregate, serve to distinguish it from other allied forms.

*Geological Position and Localities.* It is moderately abundant in the Cornbrash of the coast of Yorkshire. The foreign localities quoted by D'Orbigny are Luc (Calvados), Vezelay (Yonne), Grange-Henry, near Nantua.

TRIGONIA COMPTA, *Lyc.* Tab. XL, fig. 1.

*Testa ovato-trigona, subdepressa, umbonibus obtusis, depressis, latere antico brevi, rotunda, postico producto; area planata, carinis tribus delicatissimis et striis transversis tenuissimis instructis, costis (circa 12) posticè nodulosis, interruptis, antice rugis obliquis instructis.*

Shell ovately trigonal, rather depressed; umbones obtuse, depressed, not recurved; anterior side short, rounded, posterior side more produced, its border straight, sloping obliquely downwards; area flattened, with three very delicate, tuberculated carinæ, and fine transverse striations, lanceolate; post-ligamental space narrow, lengthened, and smooth. The other portion of the surface has about twelve rows of costæ, which become large, horizontal, nodulose, interrupted varices posteriorly, and form small, oblique, rather imperfectly tuberculated, but continuous costæ anteriorly, so that all the costæ reach the anterior border in an oblique rather than in a concentric direction.

The diagnostic characters are not very strongly marked, but in the aggregate are sufficiently distinctive. The delicately ornamented area separates it from *T. Moretonis*, Mor. and *Lyc.*, and the posterior, interrupted varices from *T. impressa*, Sow. From *T. Goldfussii*, Ag., it is distinguished by the smaller oblique costæ, more especially of their

posterior extremities, where they do not form large, continuous varices, bent upwards at a considerable angle, as in the latter species. *T. costatula*, Lyc., is more convex, the costæ are more regular, smooth and concentric, the area also is much larger, which imparts a subquadrate figure to the outline; other species are more remotely allied.

*Geological Position and Locality.* The slate of Collyweston, Northamptonshire, in which the specimens are usually compressed.

TRIGONIA CLYTHIA, *D'Orb.* Suppl., p. 48, Tab. XXXVII, fig. 2; Tab. XL, fig. 5.

Some fine specimens received subsequently to the printing of page 48 have enabled the artist to illustrate the more adult aspect of this species. Tab. XL, fig. 5 *a* exhibits the nodulous character of the posterior extremities of the costæ, their anterior portions remaining regular and concentric; fig. 5 is an aged specimen, exhibiting further changes. In common with many other of the Jurassic Trigonîæ in the ultimate stage of growth, the smooth costæ are no longer regular or concentric; they become less distinctly marked, broken, undulating or wrinkled, constituting the approach to the period when all ornamentation ceases.

TRIGONIA TRIPARTITA, *Forbes.* Tab. XL, fig. 4.

TRIGONIA TRIPARTITA, *Forbes.* Journ. Geol. Soc., vii, tab. 5, fig. 11.

— — — *Morris.* Catal., 1854, p. 229.

*Testa ovato-trigona, subdepressa, umbonibus obtusis sed recurvatis, latere antico rotundo, postico subconcavo obliquè declivi, antice costis lævigatis parvis obliquis crebris, posticè aliis (7—8) obliquis magnis depressis, nodulatis; area subconcava, sulco mediano obliquo, costis transversalibus penes apicem instructis.*

Shell ovately trigonal, rather depressed; umbones obtuse, but recurved; anterior margin rounded; posterior margin somewhat concave, sloping obliquely downwards; the anterior side has numerous (about thirty) delicate, oblique, smooth costæ, which are interrupted postically by others which cross them nearly at right angles; the latter costæ (about seven or eight) are large, nodulous and depressed, the two latter only reach the lower border; the marginal carina is but little conspicuous; the area is somewhat concave, it is transversed by a mesial furrow, and has a few transverse costæ near to the apex. Our specimen is slightly imperfect at the apex and at the inferior border.

*Geological Positions and Localities.* A single example from the Cornbrash of Chippenham, in the collection of W. Walton, Esq. This pretty species was also obtained by the late Professor E. Forbes in a stratum of yellowish, crumbly limestone and shale, beneath the Oxford Clay at Lock Staffin, in the Isle of Skye, associated with fresh-water and marine



testacea, which are believed to represent estuary conditions, a geological horizon which possibly is not very dissimilar to that of our specimen.

TRIGONIA ARATA, *Lyc.* Tab. XL, fig. 2.

*Testa ovato-trigona, subdepressa, umbonibus antemedianis, obtusis depressis, latere antico brevi, rotundo, postico obliquè declivi, area planata, oblique irregulariter, striatis, carina marginali subnullo, lateribus costis antice obliquis, posticè angulatis, depressis, simplicibus. Testa ætate juniore costis concentricis simplicibus.*

Shell ovately trigonal, somewhat depressed; umbones anterior to the middle of the valves, obtuse and depressed; anterior side short, rounded; posterior side sloping obliquely down; area flattened, with transverse, irregular striations; marginal carinæ not conspicuous, and obsolete posteriorly; the sides of the valves with numerous closely arranged, oblique, plain costæ, which are bent upwards posteriorly at an obtuse angle, and meet the area at a right angle.

The costæ are rounded and rather depressed; they become more distantly arranged posteriorly, but only slightly increase in size. The young shell has the costæ regular and concentric; the marginal carina is small, but forms a distinct elevation; a specimen more aged than the one selected for our figure has the posterior portions of the costæ slightly nodulous; anteriorly they become waved and irregular.

*Geological Positions and Localities.* A rare species; Mr. Walton's specimens are from the Forest Marble of Farleigh, near Bath; it has also occurred in the same position near to Cirencester.

TRIGONIA BATHONICA, *Lyc.* Tab. XL, fig. 3.

*Testa subtrigona, depressa, umbonibus altis medianis, latere antico et postico subrecto, obliquè declivi, lateribus costis elevatis, angustis, crebris, subundulatis, et spinulosis, obliquè instructis; area parva planata obliquè striata, carina marginali minimo, subnullo.*

Shell subtrigonal, short, depressed; umbones elevated, mesial, and not recurved; anterior and posterior borders nearly straight, sloping obliquely downwards, the surface with numerous (about twenty-four) narrow, elevated, spinose, and somewhat undulated oblique costæ, which are directed from the marginal carina antecially downwards, and all reach the lower margin; the area is narrow and obliquely striated; the marginal carina is very small, and rather indistinct.

The narrow, ridge-like costæ have numerous minute, obtuse spines, which impart roughness to the surface; they are distinct, rather irregular, and therefore very different from the serrated, elevated, regular costæ of *T. striata*, Miller, and its allied species; the



general aspect resembles *T. duplicata*, Sow., but it has no bifurcating costæ near to the lower border, and is also destitute of concentric costæ near to the apex. The sole specimen at our disposal is imperfect at the posterior extremity; it has twenty costæ, and would require about four others to complete its surface. Possibly *Trigonia Cybele*, D'Orb., from the Great Oolite of Luc, may not differ from this species, but the seven words allotted to it in the 'Prodrôme' of that author are insufficient to characterise it.

The figure is nearly that of an equilateral triangle, each of the sides having a length of about an inch.

*Geological Position and Locality.* In rubbly, hard, ferruginous Oolite (Great Oolite) from the Box Tunnel; communicated by W. Walton, Esq.

CARDIUM LINGULATUM, *Lyc.* Tab. XXXIII, figs. 2, 2 a; Tab. XXXV, figs. 11, 11 a.

*Testa ovato-oblonga, mediocriter convexa, umbonibus prominentibus, medianis, subacutis, valvis marginibus ellipticis curvatis, rugis concentricis irregularibus, striisque tenuibus, delicatè impressis; postice striis obliquis regularibus decussatis.*

Shell ovately oblong, moderately convex; umbones prominent, mesial, and subacute; the anterior, posterior, and inferior margins of the valves are elliptically curved; the surface has numerous irregular, concentric rugæ, and delicate, regular striations; the posterior side has some regular, oblique striations, which decussate those which are concentric. The height and the transverse diameter are equal.

Allied to *Cardium cognatum*, Phil., but the latter has much greater convexity, it has larger and less pointed umbones, its surface is also destitute of the concentric rugæ and striations.

*Geological Position and Locality.* The Great Oolite of Kirklington, Oxon., collected by J. F. Whiteaves, Esq.

CARDIUM INCERTUM, *Phil.* Tab. XXXV, figs. 14, 14 a.

CARDIUM INCERTUM, *Phil.* Geol. York., i, pl. 11, fig. 5.

UNICARDIUM INCERTUM, *D'Orb.* Prodrôme, i, p. 279, No. 323.

CARDIUM INCERTUM, *Morris.* Catal., 1854, p. 192.

*Testa suborbiculari convexa, lævi, umbonibus submedianis elevatis subacutis incurvis, margine antico concavo, lunula subnulla; latere postico planato angulo obliquo formante, margine postico subrecto inferne angulato; lateribus plicis concentricis paucis, irregularibus et tenuibus.*

Shell suborbicular, moderately convex, smooth; umbones mesial or slightly antero-mesial, elevated, acute, and incurved; anterior border concave and rounded; lunule scarcely

defined; posterior side forming a flattened area, well separated from the other portion of the surface by a clearly defined, oblique, and acute angle; the posterior border, at first curved, slopes suddenly downwards, nearly in a straight direction, forming an angle at its junction with the lower border; the surface has a few faintly marked, irregular, concentric plications.

*Dimensions*.—Length, 13 lines; height,  $11\frac{1}{2}$  lines; diameter through both of the valves, 8 lines. The hinge has not been examined.

*Geological Positions and Localities*. The fine specimen figured was collected by J. F. Whiteaves, Esq., in the Great Oolite of Kirklington, Oxon. It occurs rarely in the Inferior Oolite of Blue Wick; it was also collected in the roe stone of the Inferior Oolite at Leekhampton Hill by the Rev. P. B. Brodie.

CARDIUM COGNATUM, *Phil.* Tab. XXXVI, figs. 3, 3 *a*.

CARDIUM COGNATUM, *Phil.* Geol. York., i, t. 9, fig. 14.

— COGNATUM, *Morris*. Catal., 1854, p. 192.

UNICARDIUM COGNATUM, *D'Orb.* Prodr., Et. x, No. 324.

— — *Oppel*. Juraformation, p. 410.

CARDIUM — *Leckenby*. Journ. Geol. Soc., xv, pl. 3, fig. 8.

*Testa ovato-orbiculari, convexa, umbonibus magnis, medianis, subrectis, margine antico et postico, elliptico curvato, lunula nulla; valvis striis concentricis, crebris, instructis; postice striis radiantibus obliquis decussatis.*

Shell ovately orbicular, convex; umbones large, prominent, mesial, straight, or directed slightly forwards; the anterior and posterior margins of the valves are curved elliptically; there is no lunule; the whole surface has very densely arranged, delicate, concentric striations; the posterior side is not compressed, but has some oblique, faintly marked striations, which produce a roughened surface where they decussate the concentric striations.

The specific characters are not strongly defined, and reside more in the general figure than in the ornamentation of the surface; the Cornbrash specimens have a thin, shining test, and the striations can scarcely be distinguished without the aid of a magnifier; the posterior side is scarcely so much produced as the other, and the greatest convexity of the valves is placed a little posterior to the mesial line; the Kelloway Rock examples are smaller.

*Cardium cognatum* is nearly allied to an inferior Oolite species, casts of which are very common in the Cotteswold Hills; the latter fossils are more ovate, the muscular scars more strongly impressed; the test is much more thick; the striations, both concentric and oblique, are more strongly defined, especially the oblique striations



upon the posterior side, which deeply indent the shell, and are therefore always conspicuous. The *Cardium cognatum* of Goldfuss is a very different shell, having a posterior angle and oblique umbones. D'Orbigny ('Prodrome') has arranged our species with his genus *Unicardium*, in which he has been followed by Dr. Oppel ('Juraformation'); but, having examined the muscular impressions and also those of the hinge, I can affirm that Professor Phillips correctly discriminated the genus.

*Geological Positions and Localities.* The specimens figured are from the Cornbrash of Scarborough; it occurs also in the Kelloway Rock of the same neighbourhood and in Wiltshire.

CARDIUM WITCHELLI, *Lyc.* Tab. XL, fig. 36.

*Testa parva ovato-trigona, convexa, umbonibus magnis prominentibus medianis, sub-acutis, latere posteriore angulo obliquo et area postica planata, in medio sulco obliquo instructo; dorso striis tenuissimis concentricis regularibus.*

Shell small, ovately trigonal, convex; umbones mesial, prominent, and somewhat pointed; the anterior and lower margins are rounded; the posterior margin is somewhat angulated at its lower extremity; the posterior side has a conspicuous, oblique angle, separating a flattened, smooth, posterior area, which is traversed by a mesial, oblique furrow; the other portion of the surface has very fine, regular, concentric striations. The height and length are equal; the diameter through both the valves is somewhat less.

The abruptness of the posterior angle, the flattened, smooth area, with its mesial groove, appear to separate it from other allied Jurassic species. Possibly it may be a dwarfed representative of a much larger form.

*Geological Position and Locality.* The Great Oolite of Bussage, near Bisley Common; the process of crushing shelly portions of the white Oolite has yielded this little species to Mr. Witchell.

CYPRICARDIA CAUDATA, *Lyc.* Tab. XXXVI, figs. 8, 8 a.

*Testa transversa, subtrigona, obliqua, subdepressa, umbonibus magnis, elevatis, sub-involutis, incurvis, latere postico oblique declivi, obtusangulo instructo; lunula depressa; valvis striis longitudinalibus tenuissimis, inæqualibus, latere antico semel striis radiantibus tenuissimis decussatis. Nucleo striis obscuris radiantibus et concentricis.*

Shell transverse, subtrigonal, oblique, rather depressed; umbones large, elevated, and subinvolute; the posterior side slopes obliquely downwards, and has a slightly defined, obtuse angle; the anterior side is moderately produced; the lunule is strongly defined;



the lower portion of the anterior border is elliptically curved ; the base is nearly straight ; the inner borders of the valves are crenulated ; the surface has closely arranged, delicate, unequal, longitudinal striations, which are decussated upon the anterior side by others which radiate from the umbones, and when the outer layer of the test has been removed a series of strongly marked, radiating striations are exposed over the whole of the valve ; both kinds of striations are also impressed more or less distinctly upon the nucleus.

This delicately ornamented *Cypricardia* might at the first glance be mistaken for a depressed variety of *Cypricardia cordiformis*, Desh., a shell which in the young condition possesses great differences of figure ; it will be found, however, that *Cypricardia caudata* is more depressed, more trigonal, the anterior side more lengthened, and the posterior angle much less defined, so that the portion of the surface posterior to it is even somewhat convex ; but in *Cypricardia cordiformis* it is flattened or often slightly concave in some instances ; the entire absence of ornamentation, both upon the test and the nucleus, is another distinctive feature. The fine specimen figured has the area delicately preserved, and exhibits the ligament ; the test is of moderate thickness, and the inner borders of the valves are crenulated ; an exposed portion of the nucleus has striations corresponding to those upon the inner layer of the test.

*Geological Position and Locality.* The Cornbrash of Northamptonshire ; also in the Forest Marble of Wiltshire, obtained by W. Walton, Esq.

ISOCARDIA MINIMA, Sow. Tab. XXXVI, figs. 1, 1 a.

ISOCARDIA MINIMA, Sow. Min. Con., t. 295, fig. 1.

— — Phillips. Geol. York., i, t. 7, fig. 6.

— — Morris. Catal., 1854, p. 204.

— — ? Quenstedt. Der Jura, p. 443, pl. 60, fig. 17.

Non ISOCARDIA MINIMA, Goldf. Pet., p. 211, t. 140, fig. 18.

*Testa crassa, lævigata, tumida, umbonibus parvis submedianis incurvis, margine dorsali oblique-curvato, lunula excavata ; lateribus striis concentricis crebris æqualibus, tenuissimis instructis.*

Shell thick, smooth, convex ; umbones small, somewhat oblique, and placed a little anterior to the middle of the valves ; dorsal border curved obliquely ; lunule excavated ; the surface of the valves with very delicate, closely arranged, concentric striations.

A smooth, short, rounded, and moderately convex shell, with rather small umbones, quite different from the casts figured by Goldfuss and attributed by him to this species, but which probably belong to the genus *Cardium*.

The single figure given by Quenstedt is much more inflated, with larger umbones,

and is probably also distinct; it is from a lower geological position, associated with *Trigonia signata*, Ag., and other Inferior Oolite fossils of that stage.

Another shell erroneously attributed to our species is *I. minima*, Damon ('Geol. Weymouth,' Suppl., pl. iv, fig. 7), from the Coral Rag of Weymouth; it is much more oblique, with produced umbones.

The figures given in the 'Mineral Conchology' and in the 'Geology of Yorkshire' may each be objected to for the great prominence of the umbones and the large excavation of the lunule. The Yorkshire examples, which are very well preserved, differ somewhat from each other in the degree of their obliquity; some have a slightly defined, oblique, posterior angle. The height and length are usually equal, the diameter through the valves being one fourth less.

*Geological Position and Locality.* The Cornbrash of the Yorkshire coast, in which it is not uncommon.

ISOCARDIA TENERA. Tab. XXXVIII, figs. 5, 5 *a*, 5 *b*.

ISOCARDIA TENERA. Gr. Ool. Monog., t. 7, fig. 1, part 2, p. 66.

— — Ibid., t. 38, fig. 5, Supplement.

As the figures given in the former portion of this Monograph represent a specimen deprived of the test, a fine example in a perfect condition is now given, together with a magnified figure of the ornamentation of the surface. The Cornbrash and the Lower Calcareous Grit of Yorkshire yield specimens with the test very beautifully preserved, brown and shining. One from the former rock has been selected; the valves have delicate, regular, concentric striations; and when a portion of the external lamina of the test has decomposed, the striations are decussated by others radiating from the umbones, as is also seen in *Isocardia nitida*; these radiating striations belong only to the inner layer of the test.

ISOCARDIA NITIDA, *Phil.* Tab. XXXVIII, figs. 6, 6 *a*, 6 *b*.

ISOCARDIA NITIDA, *Phil.* Geol. York., i, pl. 9, fig. 10.

— TRIANGULARIS, *Bean.* Mag. Nat. Hist., 1839, p. 60, fig. 20.

— NITIDA et I. TRIANGULARIS, *Morris.* Catal., 1854, p. 204.

*Testa crassa, nitida, inflata, ovato-trigona, umbonibus medianis, altis, acuminatis, subinvolutis, latere postico angulo obliquo acuto et area postico subconcavo; basi postice sinuato; valvis striis regularibus, longitudinalibus, crebris; nucleo laevi.*

Shell thick, shining, moderately inflated, ovately trigonal; umbones mesial, elevated, acuminate, subinvolute; the posterior side with an oblique, acute angle, which separates

a slightly concave, posterior area ; the base is sinuated posteriorly ; the sides of the valves have closely arranged, regular, delicate, longitudinal striations. The nucleus is smooth.

The anterior side is more produced and less inflated than *Isocardia tenera*, Sow., from which, also, it differs in having an acute posterior angle. When the external shining surface has been abraded, it becomes the *Isocardia triangularis* of Bean, with radiating striations, which indent the longitudinal ridges, a feature of which there are analogous examples in some species of *Ceromya*, *Pecten*, &c. The inner border of the valves is crenulated, and the ultimate stage of growth is distinguished by a deeply grooved, longitudinal fold.

Length, 14 lines ; height, 11 lines ; diameter through the valves, 10 lines.

*Geological Position and Locality.* The Cornbrash of Scarborough, in which it is not uncommon.

LUCINA STRIATULA, *Buv.* (var.). Tab. XXXVIII, fig. 7.

LUCINA STRIATULA, *Buvignier.* Paléont. de la Meuse, Atlas, p. 12, pl. 12, figs. 6, 7, 8.

*Testa orbiculari, depressa, striis concentricis, tenuibus, interdum majoribus et striis radiantibus obsoletis decussata; cardine subbidentato; impressione musculari anteriore longa, angusta, posteriore obovata; impressione palliali rugosa, substriata, sulco obliquo incurvo notata.* (Buvignier.)

Shell suborbicular, depressed, inequilateral; anterior margin horizontal and nearly straight; outline of the borders of the valves rather irregular; the surface with very delicate, densely arranged, and a few distant, large, concentric striations, decussated by numerous faintly marked, longitudinal lines; anterior muscular impression lengthened, narrow, the posterior one obovate; the pallial impression rugose, with an obliquely curved sulcus. Height and transverse diameter equal.

The original of our figure is less transverse than that of M. Buvignier, but in other particulars strictly agrees with it; it is much less convex than *L. rotundata*, Roem., and the surface ornamentation is quite distinct, but the outline of the two species is very similar.

*Geological Positions and Localities.* Collected in the Great Oolite of Kirklington, Oxon., by Mr. Whiteaves. M. Buvignier records it from the Upper Coral Rag of the Meuse. Casts which are not uncommon in the Coral Rag of the southern counties of England appear to belong to the same species.



LUCINA ? BURTONENSIS, *Lyc.* Tab. XL, figs. 20, 20 *a*, 20 *b*.

*Testa suborbiculata, depressa, umbonibus subangulatis antrorsum curvatis, latere postico area depressiuscula, superficie striis tenuibus concentricis crebris notatis.*

Shell suborbicular, depressed ; umbones antero-mesial, angulated at their extremities, and curved forwards ; the posterior side has a depressed, oblique area, without any angle ; the surface has very delicate, closely arranged, regular, concentric striations ; the hinge-border is short, and slightly curved.

As the hinge has not been exposed, some doubt may exist whether it is really a *Lucina* ; the umbones are more produced than is commonly seen in that genus.

*Geological Position and Locality.* The Forest Marble of Burton Bradstock, Dorset, in the collection of W. Walton, Esq.

LUCINA BEANII, *Bean*, sp. Tab. XXXVIII, fig. 3.

ASTARTE ROTUNDATA, *Bean*. Mag. Nat. Hist. 1839, *non* Roemer.

*Testa tumida ovato-obliqua, umbonibus antemedianis, magnis, incurvis, margine cardinali oblique-declivi, curvato, margine antico brevi, arcuato curvato ; valvis striis irregularibus, plicisque semel instructis.*

Shell somewhat inflated, oblique, ovate ; umbones prominent, obtuse, incurved, placed anterior to the middle of the valves ; hinge-margin lengthened, curved, sloping obliquely downwards ; anterior margin short, rounded ; lunule very slightly excavated ; the surface of the valves has irregular, concentric striations, and also a few large plications of growth. The interior has not been exposed, but neither the hinge-margin nor the anterior border possesses the usual characters of *Astarte*, the lunule being nearly obsolete. It is shorter and more convex than *Lucina crassa*, nor does it nearly resemble any other contemporaneous species.

Height and lateral diameter nearly equal ; diameter through both the valves, one third less.

*Geological Position and Locality.* The Cornbrash of Scarborough, in the collection of Mr. Leckenby.

CORBIS NEPTUNI, *Lyc.* Tab. XXXV, fig. 19.

*Testa transverse ovali subæquilatera, concentrice costata, margine cardinali curvato, oblique declivi, lunula magna excavata, umbonibus medianis subdepressis, antrorsum curvatis ; costis concentricis regularibus angustis, striisque interstitiis instructis.*

Transversely oval, convex, nearly equilateral ; umbones rather depressed, curved for-

wards; lunule large, excavated; hinge-border curved and sloping downwards; the extremities are rounded and the base curves elliptically; the concentric costæ are regular, narrow, elevated, the interstitial spaces having delicate longitudinal striations. The convexity is moderate beneath the umbones, the extremities of the shell being rather compressed; the general figure approaches to *C. Leymerii*, Buv., but that species has the posterior side shorter and less rounded. The present shell is more lengthened than is usual with the Jurassic species, and the concentric costæ are less conspicuous.

Length, 19 lines; height, 12 lines; diameter through the valves, 9 lines.

*Geological Position and Locality.* The upper portion of the Great Oolite, near Minchinhampton, in pale, buff-coloured Oolite; few specimens have been obtained, and these, for the most part, are only casts.

CORBIS ELLIPTICA, *Whiteaves*, MSS. Tab. XXXV, fig. 1.

*Testa ovato-elongata, depressa, umbonibus parvis medianis, margine antico subhorizontali, postico oblique declivi; basi elliptico curvato; superficie rugis longitudinalibus regularibus, magnis, elevatis, crebris.*

Shell ovately elongated, rather depressed; umbones small, but little elevated, mesial; anterior margin nearly horizontal; posterior margin sloping obliquely downwards; the two extremities of the shell are rounded, and the base is curved elliptically; the surface is ornamented with large, elevated, longitudinal, regular, and closely arranged rugæ.

Length,  $7\frac{1}{2}$  lines; height, half the length.

A small, depressed, and unusually lengthened Corbis, which will not readily be mistaken for any other known Jurassic species.

*Geological Position and Locality.* The Forest Marble of Kidlington, Oxon., collected by Mr. Whiteaves.

CORBIS ROTUNDA, *Walton*, MSS. Tab. XL, fig. 17.

*Testa crassa, ovato rotundata, umbonibus magnis medianis antrorsum curvatis, lateribus sub-æqualibus postice subcompressa, superficie rugis concentricis magnis, crebris, sub-æqualibus; ætate adulto rugis obsoletis; cardo dente antico laterali magno.*

Shell thick, ovately orbicular, subglobose; umbones large, mesial, curved forwards; the sides nearly equal, but the posterior side is slightly compressed and shortened; the surface with large, closely arranged, concentric, but somewhat unequal rugæ, which degenerate in the adult state and nearly disappear:

It has sometimes been mistaken for *Sphæra Madridi*, but it is more orbicular, and the

umbones are larger; the concentric rugæ will also at once distinguish it, as the young shell of *S. Madridi* is smooth.

*Geological Positions and Localities.* The Great Oolite of Hampton cliffs; the Cornbrash of Laycock. In the collection of W. Walton, Esq.

OPIS LECKENBYI, *Wright*. Tab. XXXVII, figs. 9, 9 a.

OPIS LECKENBYI, *Wright*, in Proc. Geol. Soc., vol. xvi, part 1, 1860.

*Testa crassa, trigona, obliqua, fornicata, inæquilatera, cordiformi, transverse regulariter costata, postice acute carinata, umbonibus magnis elevatis, anticis, involutis, latere antico brevissimo, postico subrecto oblique declivi; lunula magna profunda, marginibus obtusis, striatis; costis transversis, regularibus, angustis, subacutis; valvis striis longitudinalibus et decussantibus subtilissimis instructis.*

Shell thick, trigonal, oblique, very convex, and inæquilateral, cordiform, with transverse, regular costæ; a large, flattened, posterior area is separated from the other portion of the shell by an elevated, acute carina, anterior and parallel to which is a slight depression; the umbones are large, elevated, much inclined forwards, and involute; the anterior side is very short, having a large and deep lunule, whose margin is rounded and striated; the costæ upon the sides of the valves are regular, narrow, subacute, and not much elevated; the wide, posterior area has large, oblique striations; the costated portion is covered with extremely fine perpendicular and decussating striations, which are only distinguishable under a magnifier.

Height, 15 lines; length, 15 lines; diameter through both the valves, 13 lines.

A large and elegant species, distinguished from *Opis lunulatus*, Sow., by the more convex figure, the rounded margins of the lunule, and by the more acute and more densely arranged costæ; the posterior carina and bordering sulcation are also very prominent features; the costæ under a magnifier exhibit a beautifully decussated surface.

*Geological Position and Locality.* The Cornbrash of Scarborough; a single specimen in the collection of Mr. Leckenby.

OPIS PULCHELLA, *D'Orb.* Part II, Tab. VI, fig. 3, p. 80.

OPIS PULCHELLA, *D'Orbigny*. Prodrôme, i, p. 307.

— LUNULATUS, var. Great Ool. Mon., Pal. Soc., part 2, pl. 6, fig. 6, p. 80.

*Espèce voisine de l'O. lunulata, mais bien plus courte et moins oblique, presque carrée ornée de côtes concentriques.*" (D'Orbigny.)

The experience derived from a multitude of examples leaves no room to doubt that the



Minchinhampton Opis allied to *O. lunulatus* is distinct from the typical Inferior Oolite shell, and that D'Orbigny has correctly indicated its distinctive characters in the brief sentence above quoted ; our figures in Part II, Tab. VI, faithfully represent the Great Oolite species.

OPIS LUCIENSIS, *D'Orb.* Tab. XL, figs. 19, 19 *a*.

OPIS LUCIENSIS, *D'Orbigny.* Prodrôme, i, p. 307, No. 106.

*Testa subtrigona, postice acute carinata, umbonibus prominentibus acutis, lunula permagna, profunda, lævigata, inferne rostrata, area posteriora sulco obliquo instructo ; superficie striis tenuibus concentricis, interdum obsoletis.*

Shell subtrigonal, short, posteriorly acutely carinated, with a conspicuous, oblique sulcus upon the post-carinal area ; the umbones are elevated, acute, moderately incurved ; the lunule is very large and deeply excavated, occupying the entire anterior side ; the surface is smooth, with an acute, plain margin, its lower extremity forming a rostrated projection ; the posterior surface of the valves has very delicate, concentric striations, which are only partially visible.

It is allied to *O. pulchella*, but is shorter, less convex, the umbones are more prominent and less incurved, the lunule is very much larger, the posterior keel more acute, the surface more smooth.

*Geological Position and Locality.* The Great Oolite of the Box Tunnel, near Bath, in the collection of W. Walton, Esq.

CORBULA ATTENUATA, *Lyc.* Tab. XXXVII, figs. 6, 6 *a*.

*Testa convexa, parva, subæquilatera, transversa, longitudinaliter, subillissime striata ; latere posteriore attenuato, rostrato, producto ; angulo obliquo instructo ; basi leviter curvato, postice subsinuato.*

Shell small, convex, nearly equilateral, transverse, longitudinally very finely striated ; anterior and posterior borders sloping obliquely downwards ; the posterior side is attenuated ; it has an oblique angle, which separates a narrow posterior space ; its lower extremity is rostrated ; the anterior lower extremity is elliptically curved ; the lower border is lengthened, slightly curved, and posteriorly somewhat sinuated ; the umbones are small and somewhat pointed. The figure is more elongated and has less convexity than the other Great Oolite species of the genus ; the striations upon the posterior slope are bent upwards at a right angle to their direction across the valve.

Height, equal to two thirds of the length, and a third greater than the diameter through both the valves.

*Geological Positions and Localities.* This well-marked little *Corbula* has been kindly forwarded by J. F. Whiteaves, Esq., from the Great Oolite of Kirklington, Oxon.; also by W. Walton, Esq., from the Forest Marble of Laycock, Wilts.

*CORBULA INVOLUTA*, *Munst.* Tab. XXXVII, figs. 4, 4 *a*.

*CORBULA INVOLUTA*, *Goldf.* *Pet.*, t. 151, fig. 14.

*CYPRINA* — *D'Orb.* *Prodrome*, i, p. 278, No. 309.

*Testa crassa, parva, perinflata; concentrice subtilissime striata; umbonibus magnis obtusis, submedianis; latere antico rotundo, postico rostrato, obtuse carinato et attenuato.*

Shell small, thick, greatly inflated, with very delicate, concentric striations; umbones large, obtuse, submesial; anterior side short, rounded, posterior side attenuated, rostrated, its margin concave, and forming at its lower extremity an acute angle; the posterior slope has delicate, transverse striations; it is somewhat flattened, very narrow, and is only obscurely separated from the dorsal portion of the shell by an obtuse angle; the lower border is nearly straight.

Length, one third greater than the height and the diameter through both the valves.

The foregoing description will serve to distinguish it from a small, thick, but less inflated species, abundant in the Great Oolite of Minchinhampton, and which was formerly regarded by me as *C. involuta* of Munster, and figured under that title in Part II, Tab. VI, of the 'Great Oolite Monograph,' and described in Part II, p. 97; it had previously been figured and described by Professor Buckman, in Sir R. Murchison's 'Geology of Cheltenham,' 2nd ed., p. 97, pl. 3, fig. 4, under the title of *Corbula striata*; but as that name had already been appropriated by Lamarck for an Eocene *Corbula*, it becomes necessary to change it to *C. Buckmani*, under which name it is refigured, Tab. XXXVII, fig. 8, thrice magnified.

*Geological Position and Locality.* The Great Oolite of Kirklington, Oxon.; collected by J. F. Whiteaves, Esq.

*CORBULA ISLIPENSIS*, *Lyc.* Tab. XXXVII, fig. 7.

*Testa parva, inflata, umbonibus medianis, magnis, erectis, latere anteriore rotundo, posteriore brevi, abrupte truncato, angulo obliquo instructo; valvis longitudinaliter striatis, striis magnis regularibus, lineis angustis separatis; lunula excavata; basi subrecto.*

Shell small, inflated, but subquadrate or cuculæform; umbones large, mesial, erect; anterior side rounded, its lunule excavated; posterior side short, abruptly truncated, with an oblique and subacute angle separating a posterior smooth and slightly concave area; the lower border is nearly straight; the dorsal surface has large, regular,



longitudinal striations, separated by elevated, narrow lines, which disappear at the posterior angle.

The height, length, and diameter through the united valves are nearly equal; the test is thick.

The shortness of the posterior side, its angle, and the greater prominence of the umbones, will distinguish it from *C. striata*, Buck. (*C. Buckmanii*, nobis, Pl. XXXVII, fig. 8). *Corbula involuta*, Munster, has the posterior side more lengthened and rostrated, and is almost destitute of the posterior angle; the striations upon the surface are much more delicate and faintly traced, they are oblique rather than concentric or longitudinal. *Corbula cuculæformis*, Kock and Dunker, is also allied to it, but with the figure less inflated and with more pointed umbones; it is therefore, probably, distinct. Possibly *C. amata*, D'Orb., may be identical with our species, but unfortunately the few words of description in the 'Prodrome' of that author are insufficient to characterise it; the same remark will also apply to his *C. Aglaya* and *C. Alimena*.

*Geological Position and Locality.* The Bradfordian beds of Islip, Oxon.; collected by J. F. Whiteaves, Esq.

#### CORBULA HULLIANA, Mor. Tab. XXXVII, fig. 5.

CORBULA HULLIANA, *Morris*. Hull. Mem. Geol. Surv., Cheltenham, 1857, pl. 1, fig. 6.

*Testa crassiuscula, inflata, ovato-trigona, subæquivalvi, subæquilaterali, antice producta, rotunda, postice attenuata, sulco obliquo et carina marginali obtuse; umbonibus magnis subacutis incurvis; basi subarcuato aut subrecto; lateribus costis obliquis angustis, elevatis, regularibus postice undulatis; striis radiantibus decussatis.*

Shell of moderate thickness, much inflated, ovately trigonal, subæquivalve, subæquilateral; umbones large, incurved, and pointed; anterior side produced and rounded, posterior side more attenuated, with an oblique groove and submarginal, obtuse, rugose keel, the base arcuated, or in other specimens nearly straight and slightly irregular; the surface of the valves with prominent, oblique, regular, narrow costæ, which are slightly undulated posteriorly; occasionally the left valve exhibits towards the middle of its lower portion a few perpendicular striations, which decussate the costæ and render the lower margin dentated.

The largest of the British Oolitic Corbulæ, with the hinge-characters strongly marked; the valves are less thick than usually obtains in the genus; it is also apparently equivalve; a well-preserved specimen of the left valve is destitute of the perpendicular striations.

*Geological Position and Localities.* The specimen figured in the 'Memoirs of the Geological Survey of Great Britain' was obtained in the Forest Marble near to Northleach; it occurs in the same position at Hinton, at Farleigh, and at Kidlington, Oxon., specimens



have been forwarded to me by Mr. Walton and by Mr. J. F. Whiteaves; at the Oxfordshire locality, the specimens are small and usually compressed.

*CORBULA AGATHA*, *D'Orb.* Tab. XL, figs. 28, 28 *a*.

*CORBULA AGATHA*, *D'Orb.* Prodrôme, i, p. 307, No. 100.

*Testa parva, subglobosa, lævigata, nitida, umbonibus magnis, obtusis, medianis, erectis, latere anteriore rotundo; lunula magna, concava, cordata; latere posteriore brevi, subcarinata, truncata.*

Shell small, globular, smooth, shining; umbones large, obtuse, mesial, erect; anterior side rounded, lunule large, cordiform, concave; posterior side very short, with a faintly marked oblique carina, and a truncated posterior border; the surface has a few delicate, irregular folds of growth; it appears to be equivalve.

The diameter through both the valves is equal to the height, and somewhat less than the length.

*Corbula Deshaysea*, Buv., is also a smooth species, but less short, the posterior border being also slightly sinuated. *Corbula Macneillii*, Mor., another smooth shell, is much more oblique, and more produced posteriorly. *Corbula obscura*, Sow., appears to be less convex, and to have the posterior side more produced.

*Geological Position and Locality.* The Forest Marble of Cirencester and of Wiltshire.

*Genus*—*SOWERBYA*, *D'Orb.*, 1850.

*ISODONTA*, Buv. Bull. Soc. Géol. de Fr., sér. 2, t. 8, p. 353, 1851.

Shell equivalve, subequilateral, the valves close fitting; hinge in the right valve, with two oblique, diverging, symmetrical cardinal teeth separated by a mesial trigonal pit, and two lamellar lateral teeth separated from the hinge-border by longitudinal grooves. The left valve with a projecting conical tooth between two oblique pits; lateral teeth two, longitudinal, lamellar, projecting and united to the superior border. Ligament external. Muscular impressions small, rounded, deeply marked; pallial impression emarginated posteriorly.

M. D'Orbigny in his 'Prodrôme de Paléontologie,' vol. i, 13 Et., p. 362, characterised his genus Sowerbya as follows:—"Sowerbya, D'Orb., 1847.—Coquille voisine des *Mastra* par son sinus, mais avec des dents laterales énormes, et une fossette interne ligamentaire simplement creusée."

It appears from the above quotation that M. D'Orbigny was acquainted only with the hinge of the right valve of his *Sowerbya crassa*, upon which species the genus was founded, and that he mistook the mesial dental pit for a fosse destined to receive an internal ligament. In 1851, M. Buvignier having worked out the details of the generic characters from specimens obtained in the upper ferruginous Oolite of the Oxfordian strata of Ornes (Mense), and Launoy (Ardenne), gave them to the public in the 'Bulletin of the Geological Society of France,' sér. 2, t. 8, p. 353, under the new generic designation of *Isodonta*. It is to the researches of M. Buvignier, therefore, that we are indebted for a full and accurate description of *Sowerbya*. The same author states that M. Terquem has discovered one nearly allied to the typical form in the Bradfordian beds of the Mozelle.

The Jurassic rocks of England contain upwards of five species of *Sowerbya*:—1, *S. triangularis*, from the Oxfordian and Lower Oolites of Yorkshire; 2, *S. Woodwardi*, from the Great Oolite of the Minchinhampton district; 3, a small abruptly truncated species from the Coral Rag of Yorkshire and Oxfordshire; 4, a small subæquivalve shell, with a posterior strongly marked oblique angle from the Coral Rag of Bullingdon; 5, an internal cast of a large species determined by Mr. Woodward, and figured by Mr. Damon in his 'Geology of Weymouth,' from the Portland Oolite, under the name of *S. Dukei*.

SOWERBYA TRIANGULARIS, *Phil.*, sp. Tab. XXXV, figs. 3, 3 a, 3 b.

CUCULLÆA TRIANGULARIS, *Phil.* Geol. York., i, pl. 3, fig. 30.

ARCA TRIANGULARIS, *D'Orb.* Prodr., i, p. 369.

CUCULLÆA TRIANGULARIS, *Mor.* Catal., 1854, p. 197.

*Testa transverse, oblonga, inflata, subæquilatera, postice oblique carinata, umbonibus parvis postero-medianis, margine inferiore angulo formante; superficie plicis longitudinalibus paucis magnis et striis longitudinalibus subtilissimis ornata.*

Shell transverse, oblong, inflated, slightly inæquilateral; the posterior side the shorter, with a posterior oblique angle, separating a posterior slightly excavated surface which terminates downwards in a conspicuous angle; the anterior side is produced and curved elliptically; the umbones are placed a little posterior to the middle of the valves; they are small and contiguous. The surface has one or two large folds of growth, and is ornamented with longitudinal, regular, closely arranged striations, which disappear upon the posterior excavated slope.

The height is about equal to the diameter through both the valves, and to three fifths of the length.

The species exhibits much variability in the general figure, in the degree of convexity, in the prominence of the posterior angle, and in the length; differences which are not limited to a single formation or locality, as it occurs in the Yorkshire Oolites in the



Dogger, the Gray Limestone, the Cornbrash, the Kelloway Rock, and the Coral Rag ; numerous specimens are also in the Tessonian collection from Normandy, now in the British Museum. Some of these examples are almost destitute of the posterior angle, and approach so nearly in the general figure to *Sowerbya crassa*, D'Orb. = *Isodonta Deshaysea*, Buv., that they might fairly have been assigned to that species, if we had not the assurance of M. Buvignier that his specimens from two localities are in a good state of preservation, and that they are destitute of ornamentation—a feature which is always discoverable in good examples of *S. triangularis*, whether British or Foreign.

Mr. Whiteaves has figured a small species of *Sowerbya*, 'Ann. and Mag., Nat. Hist.,' August, 1861, under the name of *S. triangularis*, Phil. Having had the advantage of comparing the original specimen, through the kindness of Mr. Whiteaves, with various Yorkshire specimens of *S. triangularis*, I feel unable to coincide in the opinion that it is identical with the species of Professor Phillips ; the new Oxfordshire form is much smaller, less inflated, destitute of ornamentation ; and the posterior side is so short that '*truncata*' would be an appropriate name : it is from the Coral Rag of Oxfordshire. I have also found it in the Calcareous Grit at Scarborough Castle.

The second small species figured by Mr. Whiteaves upon the same plate under the name of *S. Deshaysea*, Buv.? also appears to be distinct from each of the foregoing examples ; the general figure is more compressed, the anterior slope is excavated, which renders its lower extremity pointed ; the whole aspect somewhat resembles a *Nucula*.

Our specimen figured is from the Cornbrash of Scarborough.

SOWERBYA WOODWARDI, *Lyc.* Pl. XL, figs. 27, 27 a, 27 b, 27 c.

*Testa ovato-trigona subdepressa, subæquilatera, latere posteriore breviori, planata, lævigata angulo obliquo diviso, dorso et latere antico striis longitudinalibus regularibus crebris, delicate instructis.*

Shell ovately trigonal, rather depressed, subequilateral, the posterior side being the shorter ; the umbones are not very prominent nor large ; the anterior and posterior borders slope obliquely downwards ; the extremities of the valves are rounded ; the surface has delicate, closely arranged regular longitudinal or concentric striations, which are separated from the smooth and flattened posterior side by a distinct angle.

It is much smaller, more depressed, more lengthened, and the umbones are much less elevated than in *S. triangularis*. Our right hand figure is imperfect at the posterior extremity, and the posterior oblique angle is not clearly shown ; the left hand figure has the anterior extremity too obtusely rounded, the specimen wanting a little of its border.

*Geological Position and Locality.* The Great Oolite of Bussage, near to Bisley



Common, collected by E. Witchell, Esq. A specimen has also been brought under my notice by S. P. Woodward, Esq., but its locality is uncertain.

TANCREDA GIBBOSA, *Lyc.* Tab. XXXV, fig. 7. Tab. XXXVI, fig. 11.

TANCREDA GIBBOSA, *Lyc.* Cott. Hills Handb., p. 121, pl. 7, fig. 4.

*Testa subtrigona, tumidula, umbonibus medianis acutis, latere antico attenuato, postice tumido subangulato; dorso lævigato, plicis incrementi, paucis irregularibus.*

Shell subtrigonal, tumid; umbones elevated, pointed, and placed a little anterior to the middle of the valves; the anterior side is rather attenuated and pointed at the lower extremity; the posterior side slopes obliquely downwards, it is somewhat tumid, and has an oblique angle slightly defined; the surface is smooth, but with a few plications of growth towards the lower border.

Height, 10 lines; length, 13 lines; diameter through both the valves, 6 lines.

It is distinguished from other Great Oolite species by the combination of a trigonal outline with a tumid figure.

*Geological Position and Locality.* It occurs rarely in the Great Oolite shelly weatherstones of Minchinhampton Common, and the Forest Marble of Farleigh, Somerset.

TANCREDA MACTRÆOIDES, *Whiteaves*, MSS. Tab. XXXV, fig. 4.

*Testa ovato trigona, convexa, umbonibus submedianis elevatis, incurvis; margine antico brevior, læviter excavato, margine postico oblique declivi, angulo oblique læviter instructo, basi elliptico curvato.*

Shell ovately trigonal, convex, with a few concentric plications; umbones antero-mesial, elevated, and incurved; anterior border the shorter, slightly concave; the extremity pointed; posterior hinge-border sloping obliquely; there is also a posterior oblique angle faintly marked.

*Tancredia gibbosa*, *Lyc.*, approximates to this species, but is more convex, with a more elevated and rounded posterior slope. *T. axiniformis*, *Phil.*, from the Inferior Oolite of Yorkshire, is more flattened, with more pointed umbones and acute posterior angle. Height two thirds of the length.

*Geological Position and Locality.* The Great Oolite of Stonesfield, Oxon., where it appears to be rare; collected by J. F. Whiteaves, Esq.

TANCREDA SIMILIS, *Whiteaves*, MSS. Tab. XXXV, fig. 9.

*Testa ovato elongata, umbonibus antemedianis, latere antico attenuato, brevior; postico convexo, angulo obtuso obliquo; basi elliptica curvata.*

Shell ovately elongated; umbones placed anterior to the middle of the valves, rather depressed and obtuse; anterior side the shorter, its upper margin slightly excavated, its lower extremity pointed; posterior side larger, more convex, with an oblique obtuse angle; the hinge-border is moderately lengthened and horizontal; the surface is smooth, the lower border is elliptically curved.

*T. extensa*, Lyc., 'Gr. Ool. Mon.,' p. 93, approximates to the present form, but has a much larger anterior side, with the umbones more elevated and mesial.

The height slightly exceeds half the length.

*Geological Position and Locality.* The Great Oolite of Kirklington, Oxon., collected by Mr. Whiteaves.

**CORBICELLA SUBÆQUILATERA**, *Lyc.* Tab. XXXV, fig. 12.

**CORBICELLA SUBÆQUILATERA**, *Lycett.* Cotteswold Hills Handbook, p. 126.

*Testa ovato-obliqua lævigata, umbonibus parvis, antero-medianis, lunula angusta, sulco ligamenti angusto, margine superiore oblique curvato.*

Shell oblique, ovate, smooth; umbones not prominent, placed a little anterior to the middle of the valves; anterior border slightly depressed, lunule narrow; superior border curved obliquely; ligamental sulcus narrow and lengthened; surface of the valves smooth, the lines of growth being only faintly impressed. The height is equal to two thirds of the length; the diameter through both the valves is equal to about half the height.

This shell presents an example of a remarkable series of Jurassic bivalves, whose characteristic features are intermediate between *Corbis* and *Tancredia*, and which may usually be discriminated without reference to the hinge; compared with *Corbis*, the more depressed form, the smallness of the anterior side, and the surface destitute of ornament, will always distinguish it; from *Tancredia* by the more ovate form, and by the absence of the posterior oblique angle. The hinge is figured upon Pl. XII, fig. 15, of the 'Great Oolite Monograph;' but the artist has scarcely extended the hinge-lamina sufficiently to exhibit the depressed posterior lateral lamellar process; the absence of the anterior lateral tooth, and the figure of the cardinal dentition, is also distinct from *Corbis*, and is more nearly allied to *Tancredia*, from which it differs chiefly in possessing a lengthened hinge-lamina and depressed remote posterior lateral tooth; these distinctive features are remarkably persistent in every example of *Corbicella*, and tends greatly to strengthen its claims to a generic distinction.

Under the name of *Corbis lucida* our species was included in Mr. Bean's list of Cornbrash Fossils, published in the 'Magazine of Nat. Hist.,' 1839, but was not accompanied by any figure or description.

*Geological Positions and Localities.* The specimen figured is a fine example from the



Cornbrash of Scarborough, in which rock it is rare. The lower grit of the upper portion of the Inferior Oolite at Rodborough Hill, near Stroud, has produced a considerable number of specimens, for the most part smaller, and sometimes more nearly equilateral; it also occurs in the same position at Leckhampton Hill; at each of these Inferior Oolite localities it is associated with a larger, more lengthened, and more depressed species. (*C. complanata*, Lyc.). *Corbis depressa*, Desh., from the Oxfordian strata of Viel, St. Remy, approaches nearly to it in the general outline, but is more depressed and somewhat less ovate.

*CORBICELLA SUBANGULATA*, Lyc. Tab. XL, fig. 9.

*Testa ovata sub-compressa, transversa, umbonibus antemedianis, mediocri magnitudine, margine cardinali oblique declivi, latere postico angulo oblique instructo, margine antico subconcavo, superficie plicis incrementi magnis irregularibus.*

Shell ovate, somewhat depressed, transverse; umbones of moderate size, placed anterior to the middle of the valves; hinge-border of moderate length, sloping obliquely downwards; the posterior side has an oblique angle; the anterior border is slightly concave; the surface has numerous plications of growth, which become large and irregular towards the lower border.

Allied to *C. complanata*, Lyc., from which it is distinguished by the strongly marked posterior angle, and by the larger umbones; our specimen is imperfect at the posterior extremity.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

*CYPRINA ISLIPENSIS*, Lyc. Tab. XXXV, fig. 13.

*Testa ovato-transversa, convexa, lævi, obliqua, umbonibus antemedianis magnis, incurvis, lunula magna, excavata, area parva lanceolata; latere postico compresso, angulo obliquo formante; basi elliptica curvata; striis concentricis tenuibus, irregularibus, subobsoletis.*

Shell ovately transverse, convex, smooth, oblique; umbones large, incurved, placed anterior to the middle of the valves; area small, lanceolate; posterior side compressed and slightly concave, forming an oblique and well-defined angle with the other portion of the surface; lower border curved elliptically, forming an angle at its junction with the posterior border. Nearly allied to *Cyprina Loweana*, Mor. and Lyc., from which it is distinguished by the larger umbones; larger lunule, by the posterior flattened or concave area, and by the well-defined oblique and acute angle, which renders the posterior extremity somewhat rostrated.



*Geological Positions and Localities.* The specimen figured was obtained by Mr. Whiteaves in the Great Oolite of Kirklington, Oxon.; it has also occurred rarely in the same formation at Minchinhampton Common, and in the Cornbrash of Islip, Oxon.

CYPRINA BELLA, *Lyc.* Tab. XL, figs. 15, 15 a.

*Testa ovato-orbiculari lævigata, subdepressa, umbonibus mediocris, antero-medianis, margine cardinali recto, subhorizontali, postice subangulata, lunula angusta vix depressa; superficie angulo postico obliquo instructo; striis incrementi crebris, irregularibus.*

Shell transverse, ovately orbicular, smooth, rather depressed; umbones of moderate size, but little elevated, placed a little anterior to the middle of the valves and curved forwards; hinge margin straight, nearly horizontal, and slightly angulated posteriorly; the lunule is narrow, and but slightly impressed; the exterior surface has an oblique angle, posterior to which the surface is flattened; the striations of growth, and delicate, numerous, and irregular.

The depressed form, posterior subhorizontal straight hinge border, and oblique posterior angle, are the features that will serve to distinguish it from allied contemporaneous forms. The numerous specimens placed at my disposal include examples from two to nine lines in length, which measurements usually exceed the height by one fifth.

*Geological Position and Localities.* The Forest Marble of Laycock and Pound Pill. In the collection of W. Walton, Esq.

CYPRINA DAVIDSONI, *Lyc.* Tab. XXXVI, figs. 6, 6 a.

*Testa ovato-orbiculari crassa, convexa, obliqua, umbonibus obtusis submedianis antrorsum inflectis, marginibus arcuatis curvatis, latere postico area subplanata, angula obtuso obliquo interdum instructo, aut nullo; lunula vix excavata, inconspicua, superficie striis concentricis irregularibus.*

Shell ovately orbicular, thick, convex, oblique, but varying much in the length and obliquity; umbones obtuse, submesial, directed forwards; margins of the valves curved elliptically and close fitting, lunule not conspicuous and scarcely excavated; the posterior side has a narrow, oblique, flattened space, sometimes separated from the other portion of the surface by an obtuse angle; in other instances there is no distinct angle; the surface has numerous irregular concentric and faintly marked plications.

Dimensions of a large specimen of medium figure; length, 17 lines; height, 15 lines; diameter through the valves, 11 lines.

It is liable to be mistaken for *Cyprina Loweana*, compared with which our shell is

shorter, more convex, the test thicker, the umbones larger, less oblique, and more obtuse ; the posterior flattened area is also a distinguishing feature when it is present.

*Geological Position and Localities.* The Forest Marble of Laycock and Farleigh, in the collection of W. Walton, Esq., of Bath.

ASTARTE UNGULATA, *Phil.*, sp. Tab. XXXV, fig. 20.

ASTARTE LURIDA, *Phil.* Geol. York., i, pl. 5, fig. 2, p. 137, non *A. lurida*, Sow.

— — *Williamson.* Trans. Geol. Soc., 2d ser., vol. vi, p. 149.

— — *Bean*, on Cornbrash Fossils, Mag. Nat. Hist., 1839.

— — *Leckenby*, on Kelloway Rock Fossils, Journ. Geol. Soc., 1858.

*Testa suborbiculari aut subquadrangulæ, depressa, inæquilatera, ad periphæriam concentricè costellata, costellis elevatis, subangularibus, concentricè subtilissimè striatis; costellis inferne evanescentibus; margine cardinali curvato, lunula subnulla.*

Shell suborbicular or somewhat subquadrangular, depressed, inequilateral ; umbones small and only slightly produced ; posterior and inferior margins rounded, lunule, obsolete ; the surface near to the umbo with elevated acute concentric rugæ, which are impressed with very delicate concentric striations ; the rugæ disappear towards the middle of the valve, the lower portion having only some plications of growth.

The character of the surface has a considerable resemblance to *Astarte Wiltoni*, 'Gr. Ool. Monogr.,' Tab. IX, f. 16 ; but the latter has the umbo much more produced, it has a distinctly excavated lunule and is more convex ; other depressed species are sufficiently separated by their ornamentation.

*Astarte lurida*, Sow., which occurs in Gloucestershire at Nailsworth in gray shale near to the upper boundary of the Upper Lias, and in the lower portion of the overlying Supraliassic Sands associated with *Ammonites variabilis*, is a very different shell, whose figure is ovately trigonal and moderately convex, with prominent apex, well-marked lunule and depressed concentric rugæ ; it does not therefore present a near approximation to our species.

*Astarte unguolata* has the height and lateral diameter equal ; the valves are moderately thick ; the size varies from 4 to 10 lines across. It is rare.

*Geological Positions and Localities.* Professor Phillips figured the interior of a valve from the Oxford Clay of Scarborough. Mr. Leckenby has recorded it in the Kelloway Rock of the same locality ; our figure is taken from a Cornbrash specimen of the same coast now in the collection of Mr. Leckenby, and formerly in that of Mr. Bean, who identified the species with that originally figured in the 'Geology of Yorkshire.'

## ASTARTE ORBICULARIS, Sow. Tab. XL, fig. 33.

ASTARTE ORBICULARIS, Sow. Min. Con., v, p. 65, tab. 444.

— — Morris. Catal., p. 187.

— — D'Orb. Prod. de Paléont., i, p. 308.

*Testa parva suborbiculari, convexa, umbonibus medianis elevatis, lunula magna, valvis costulis concentricis numerosis, depressis, interstis latioribus, subæqualibus.*

Shell small, nearly orbicular, convex; umbones mesial and produced; lunule distinctly marked, rounded, the surface with numerous (about twenty) depressed, narrow, concentric little ribs, separated by somewhat wider and nearly equal spaces, upon the posterior side the ribs are slightly undulated.

The little ribs are strongly marked upon the sides, but much less so upon the middle of the valve, and are scarcely to be distinguished upon the umbones; they are so delicate that the surface appears plain without the aid of a magnifier; this latter feature will serve to distinguish it from other small species, as *A. minima*, Phil., *A. pisiformis*, Sow., *A. Parkinsoni*, Quenst. Of other small examples of the genus, *A. pisum*, Kock and Dunker, and *A. Pontonis*, Lyc., are much less orbicular, and have more prominent costæ; *A. mediolævis*, Buv., has the ornamentation of a similar character, but the figure is ovately trigonal, and therefore sufficiently distinct.

*Geological Positions and Localities.* The upper beds of the Great Oolite near Bath, where it appears to be not uncommon; also upon the same horizon at Ancliff, Wilts. Luc (Calvados).

## ASTARTE POLITULA, Bean. Tab. XXXV, fig. 16.

ASTARTE POLITULA, Bean. Mag. Nat. Hist., 1839.

*Testa suborbiculari, convexo-plana, umbonibus antemedianis parvis, acutis, incurvis, margine cardinali curvato, fossa ligamenti, angusto, elongato, margine antico subrecto lunula lanceolata, leviter excavato; valvis striis regularibus tenuissimis concentricis, inferiore irregulariter plicatis.*

Shell suborbicular, rather depressed; umbones anterior to the middle of the valves, small, acute, incurved; hinge-border slightly curved; ligamental groove narrow and lengthened; anterior border nearly straight; lunule lanceolate and slightly excavated, its margins subacute; the surface of the valves with very fine, regular, concentric striations; the lower portion of the surface is destitute of striations, but has several irregular, concentric plications.

The convexity is moderate about the middle of the valves, but the test has not much



thickness towards the borders, the outline has a considerable resemblance to *Lucina crassa* but the latter is much thicker towards the borders of the valves, and has a different kind of surface. The hinge has not been exposed.

*Geological Position and Locality.* The Cornbrash of Scarborough; in the collection of Mr. Leckenby.

ASTARTE LECKENBYI, *Wright*. Tab. XLII, fig. 3.

*Testa crassa, transversa, ovata, subdepressa, umbonibus parvis, prominulis antero-medianis; latere antico brevi, margine rotundo, lunula subnulla; latere postico producto, margine superiori subrecto, elongato, oblique declivi; basi arcuato curvato; superficie rugis crebris concentricis et striis subtilibus ornatis.*

Shell thick, transverse, ovate, rather depressed; umbones small, prominent, placed at the commencement of the anterior third of the shell; anterior side short, its margin rounded with scarcely any lunule; posterior side produced and compressed, its superior margin nearly straight, lengthened, sloping obliquely; the base is elliptically curved; the surface has prominent, concentric, closely arranged, rounded rugæ near to the umbones, which afterwards degenerate into depressed, irregular plications; there are also fine, concentric striations.

A large species, remarkable for the depression of the valves and for the great length and straightness of the superior border, whose measurement is equal to the height or to two thirds of the entire length of the shell; the rugæ are so closely arranged near to the apex that upwards of thirty may be counted upon one fourth the height of the shell.

From *Astarte elegans*, Sow., it is distinguished by the more lengthened, depressed figure, and by the absence of a smooth, excavated lunule; it is much less orbicular and convex than *A. detrita*, Goldf.; the depressed figure, lengthened, straight, upper margin, and large rugæ, will serve to distinguish it from other large ovate species of the lower Oolites. Specimens in Mr. Leckenby's collection exceed three inches in length. It is not rare, but, in common with other large shells of the Cornbrash, it has usually undergone compression.

*Geological Position and Locality.* The Cornbrash of Scarborough, in hard, gray limestone.

ASTARTE ROBUSTA, *Lyc.* Tab. XXXV, figs. 6, 6 a.

*Testa parva suborbiculari, perinflata, umbonibus magnis medianis incurvis, margine posteriore et inferiore rotundo, lunula magna concava marginibus rotundis; valvis costis*

*concentricis, regularibus, angustis, elevatis* (16—18) *striisque subtilissimis, concentricis, impressis.*

Shell small, suborbicular, much inflated; umbones large, mesial, incurved; posterior and lower margins rounded; lunule very large, concave, its margins rounded; the surfaces of the valves have narrow, concentric, regular, elevated costæ, 16—18 in number, which are impressed by very delicate concentric striations; the intercostal spaces are upwards of three or four times the breadth of the costa.

Height, lateral diameter, and diameter through both the valves, each about 4 lines.

About thrice the size of a minute Cotteswold Inferior Oolite species which possesses a similar figure, but whose costæ are irregular. *Astarte Bulla*, Goldf., is also globose, but has only half the number of costæ. *A. integra*, Goldf., has less convexity and is more oblique; other small species, figured by Roemer, Buvignier, and by Quenstedt, have less convexity and more obliquity.

*Geological Position and Locality.* One of the more rare testacea of the Scarborough Cornbrash; in the collection of Mr. Leckenby.

#### ASTARTE PONTONIS, *Lyc.* Tab. XL, fig. 31.

*Testa parva, convexa, ovato-orbiculari, umbonibus submedianis, acuminatis, antrorsum curvatis, margine cardinali elongato, subrecto, oblique declivi, lunula magna, costata; valvis costis concentricis numerosis* (20) *elevatis, rotundis, interstiis angustis; latere superiore, area, elongata, planata et lævigata.*

Shell small, convex, ovately orbicular; umbones elevated, pointed, nearly mesial, and curved forwards; hinge-border lengthened, nearly straight, sloping obliquely downwards, forming a narrow, smooth area, separated from the costated part of the shell by an acute angle; the lunule is large, costated, and somewhat excavated; the surfaces of the valves have large, numerous (about 20) concentric, elevated, and rounded costæ, separated by more narrow interstitial spaces; adult shells have a large fold of growth near to the lower border.

A small, convex, neatly ornamented species, allied to *A. minima*, Phil., and *A. pisum*, Kock and Dunker; from the former it is distinguished by the more numerous and more closely arranged costæ, by the more pointed and more curved umbones, by the larger lunule, and by the posterior, straight, smooth, acutely bordered area; the latter feature will also separate it from *A. pisum* and from *A. supracorallina*, D'Orb.

The height and lateral diameter are about 4 lines.

*Geological Position and Localities.* It is abundant in the White Oolite (Great Oolite?) of Ponton, Lincolnshire.

ASTARTE BATHONICA, *Lyc.* Tab. XL, figs. 23, 23 a.

*Testa ovato-trigona, crassa gibbosa; umbonibus sub-anticis antrosum curvatis; lunula cordata, excavata, marginibus rotundatis, latere postico obtusangulo formante, superficie costis regularibus, rotundis, crebris, concentricis, marginibus interne denticulatis.*

Shell ovately trigonal, thick, gibbose; umbones anterior and curved forwards; lunule excavated, cordate, its margins rounded; the posterior side has an obtuse, oblique angle; the surface has closely arranged, rounded, regular, concentric costæ; the margins of the valves are denticulated internally.

Height, 6 lines; opposite diameter, 5 lines; diameter through the valves,  $4\frac{1}{2}$  lines.

A short and very convex, thick, shell, with elevated umbones and slightly truncated posterior border, which is pointed at its inferior extremity, near to which is a large fold of growth.

*Geological Position and Locality.* Hampton, Cliffs near Bath; collected by W. Walton, Esq., who states that, having found it at the base of the cliffs, some doubt may exist as to its real geological position. The mineral character of the specimen is ferruginous and identical with that of the bed of Great Oolite Corals and of other shells which unquestionably belong to the Great Oolite.

ASTARTE RUSTICA, *Walton, MSS.* Tab. XXXV, fig. 5; Tab. XL, f. figs. 8, 8 a.

*Testa parva, crassa, ovato-oblonga, plano-convexa, umbonibus parvis, antemedianis, acutis, margine, cardinali brevi, subhorizontali, antice rotundato, basi subarcuato, marginibus internis dentatis; lateribus costis angustis imprimis regularibus, deinde inæqualibus.*

Shell small, ovately oblong, moderately convex, with thickened margins, internally denticulated; umbones anterior to the middle of the valves, curved forwards, and acute; hinge-border short and horizontal, terminating in an obtuse angle. The anterior border is rounded; the lunule is only slightly excavated; the base line is nearly straight; the surface of the valves has an obscure, posterior, oblique angle; the costæ are narrow, at first regular, afterwards they become irregular and crowded.

Length, 5 lines; height, 4 lines; diameter through the valves, 3 lines.

Much variability exists in the prominence and arrangement of the costæ, which are sometimes very numerous and nearly obsolete, or they are distant and elevated. A little species, allied to *A. Voltzii*, Roem., *A. recondita*, Phil., and the young of *A. rhomboidalis*, Phil.; neither of these species, however, has the test so thickened towards the margins.

*Geological Position and Locality.* The Forest Marble of Laycock, Somerset; in the cabinet of W. Walton, Esq.



ASTARTE FIMBRIATA, *Walton, MSS.* Tab. XL, figs. 34, 34 a.

*Testa transversa, ovata, subdepressa, umbonibus antemedianis parvis, margine cardinali elongato, subrecto, obliquo, acuto; lunula magna elliptica; lateribus costulis concentricis acutis, elevatis subdistantibus; ætate progrediente crebrioribus et irregularibus instructis.*

Shell transverse, ovate, somewhat depressed; umbones small, depressed, curved forwards; hinge-margin lengthened, nearly straight, its margin acute and rendered fimbriated by the acute, projecting extremities of the costæ, which are elevated, concentric, distantly arranged, and regular in the young shell, but more closely arranged and irregular in specimens of adult growth; the lunule is large, elliptical, its margins acute.

Allied to *A. depressa*, Goldf., compared with which the umbones are less prominent and more oblique, the hinge-border more lengthened, the costæ more elevated and fewer; the convexity of the valves is also greater. The test is thinner than is usual with this genus.

Occasionally a small and ill-preserved specimen has been found in the Great Oolite of Minchinhampton, and mistaken for *A. minima*, Phil.; the costæ in the latter shell are more obtuse and more closely arranged, the general figure being more orbicular.

*Geological Positions and Localities.* The Forest Marble of Farleigh and the Great Oolite of Bussage, near Bisley Common.

ASTARTE? IGNOTA, *Lyc.* Tab. XL, fig. 10.

*Testa subovata, subdepressa, postice truncata, inferne et postice oblique subangulata, umbonibus antemedianis acuminatis, lunula parva, superficie, plicis incrementi numerosis, delicate instructis.*

Shell subovate, subdepressed posteriorly, with a truncated extremity to the hinge-border and with an oblique angle proceeding from the umbo to the inferior-posterior border; umbones antero-mesial, pointed, and curved forwards; lunule slightly impressed; the surfaces of the valves with delicate, irregular, numerous plications of growth.

The hinge not having been seen, the genus is rather doubtful; possibly it may be a *Cypricardia*.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

ASTARTE HILPERTENSIS, *Lyc.* Tab. XXXVI, fig. 10.

*Testa crassa, convexa, ovato-trigonata, umbonibus subanticis prominentibus, lunula ovata profunda, margine cardinali curvato, elongato, oblique declivi, marginibus anterioribus, posterioribus et inferioribus ellipticis curvatis; superficie plicis incrementi crebris tenuibus.*

Shell thick, convex, ovately trigonal; umbones antero-mesial, elevated, and curved forwards; lunule smooth, ovate, deep; hinge-margin lengthened, curved, sloping obliquely downwards; the anterior, posterior, and lower borders curved elliptically; the surface with delicate, numerous plications of growth.

A large, thick species, somewhat allied to *A. subtrigona*, Munst., but more convex, less angulated, and with a larger lunule.

*Geological Position and Locality.* The Cornbrash of Hilpert, Wilts, in the collection of W. Walton, Esq.

ASTARTE AYTONENSIS, *Bean MSS.* Tab. XL, fig. 13.

*Testa ovato-oblonga, valde elongata, compressa, umbonibus depressis antemedianis, lunula concava, margine cardinali subhorizontali elongata, margine inferiore parallelo; lateribus rugis ellipticis, crebris, depressis subregularibus instructis.*

Shell ovately oblong, much elongated, compressed; umbones anterior to the middle of the valves flattened; lunule concave; the hinge-margin lengthened and nearly horizontal; lower border conformable; the two extremities elliptically rounded; the surface with closely arranged, depressed, rounded, elliptical, partially irregular rugæ.

The general aspect has some resemblance to the shell figured in Part II, Pl. IX, figs. 18, 19, as a variety of *Astarte excavata*, but still more flattened and more elongated, with more conspicuous, regular, elliptical rugæ. Additional experience now leads me to rank *A. excavata*, var. *compressiuscula*, as a distinct species, and not as a dwarfed variety of the large Inferior Oolite shell; the present form is even more thin and flattened than *compressiuscula*, so much so as scarcely to allow any space for the animal.

Length nearly twice the height; the diameter through the united valves is little more than equivalent to their apparent thickness.

*Geological Positions and Localities.* The Great Oolite of Hampton Cliffs and of Comb Down, near Bath; collected by W. Walton, Esq. It occurs also in the Calcareous Grit of Ayton, near Scarborough, quite unaltered in any particular; the name from the locality having been adopted by Mr. Bean many years since, and sent to public collections, has therefore been retained.

ASTARTE FLEXICOSTATA, *Lyc.* Tab. XL, fig. 26.

*Testa transversa, subtrigona, convexa, umbonibus anticis acutis, elevatis, margine anteriore truncata, abrupte declivi inferne angula formante; lunula magna lævigata concava, margine acuto; margine inferiore subrecto; margine posteriore imprimis subhorizontali postice oblique declivi; superficie striis concentricis regularibus instructis, in medio evanescentibus.*

Shell transverse, subtrigonal, convex; umbones anterior, pointed, and conspicuous; anterior side truncated, descending abruptly, and forming an angle with the lower border at its extremity; the lunule is large, concave, smooth, with an acute margin; the lower border is nearly straight; the posterior margin is nearly horizontal for the half of its length, then slopes obliquely downwards; the shell is moderately convex, with an oblique, obtuse angle, posterior to which the surface is more flattened; it has regular striations, which follow the direction of the lines of growth; they are conspicuous near to the umbones, but disappear upon the middle portion of the dorsal surface.

Height, 5 lines; length, 7 lines; diameter through the united valves,  $3\frac{1}{2}$  lines.

*Geological Position and Locality.* Collected by E. Witchell, Esq., in the white stone (Great Oolite) of Bussage, near to Bisley Common; a single specimen.

GRESSLYA PEREGRINA, *Phil.*, sp. Tab. XXXVI, figs. 2, 2 a, b.

In addition to the specimen figured in Pl. XV, Part II of the 'Great Oolite Monograph,' it has been deemed advisable to exemplify three other variations of form, by the aid of which the intermediate connecting links may readily be imagined. This *Gresslya* is very abundant in the Cornbrash, both in Wiltshire and Yorkshire, so that ample opportunities are afforded of studying every variation of form which it presents; these, as will be seen from our figures, are so considerable and so common that it seems impossible fairly to disconnect from them some other examples of *Gresslya* from the Inferior Oolite, as *Unio abductus*, *Phil.*, *Gresslya latior*, *Ag.*, *G. conformis*, *Ag.*, *G. lunulata*, *Ag.*, *G. erycina*, *Ag.*, *G. concentrica*, *Ag.*, and perhaps also *G. zonata*, *Ag.* In all these the same kind of surface obtains, and the outer, granulated tegument is precisely identical, belonging to that section of the genus in which the radiating lines and the granules are of the most minute size, and very densely arranged. It has been usual to select for *G. abducta* Inferior Oolite examples with short forms, elevated umbones, tumid anterior sides, and compressed posterior sides; but the shortness of figure is surpassed by some from the Cornbrash, and the inflation of the anterior side varies in amount with every specimen. From these, probably, must be separated *G. latirostris*, *Ag.*, which attains to large



dimensions, with a lengthened general form, compressed anterior side, and large longitudinal plications over the whole of the surface; it appears to be comparatively rare, and belongs to the upper stage of the Inferior Oolite.

THRACIA AMYGDALOIDEA, *Lyc.* Tab. XLIII, fig. 4.

*Testa convexa, elongata, umbonibus depressis submedianis, latere antico producto, rotundato; postico subcompresso, attenuato, basi curvato, plicis longitudinalibus paucis, leviter instructis.*

Shell elongated, convex; umbones postero-mesial, depressed; anterior side produced, its margin curved elliptically; posterior side rather compressed and attenuated, its superior border slightly excavated; the base is nearly straight; the surface has a few faintly marked, longitudinal plications of growth.

Compared with other examples of the genus, the length and the convexity are considerable; the umbones are likewise much depressed, obtuse, and but little conspicuous; the posterior angle is only distinguishable near to the umbones; the posterior extremity is slightly truncated. The height only very slight exceeds half the length.

*Geological Position and Locality.* Associated with valves of *Myacites calceiformis* in flaggy, argillaceous Oolite, upon the western border of Minchinhampton Common, at the lower boundary line of the Great Oolite; a single specimen.

MYACITES CALCEIFORMIS, *Phil.*, sp. Part II, Tab. XI, fig. 2; et Tab. XLII, figs. 1, 1 a.

As this shell possesses considerable variability of figure, another example is given from the Cornbrash of the Yorkshire Coast. In the former description (p. 114, line 8), these words should be erased—"in the upper beds of the Inferior Oolite." An examination of numerous Yorkshire specimens has proved that they were all obtained in the Cornbrash, including the original specimen figured in the 'Geology of Yorkshire,' which was erroneously placed with the Inferior Oolite fossils, and figured with them in pl. xi of that work. The Cornbrash specimens have the test with its granulated tegument well preserved, but usually the fossil has undergone some compression or distortion. The former figure, Plate XI, fig. 2, represented a Minchinhampton specimen from the base of the Great Oolite. An Inferior Oolite shell frequently mistaken for *Myacites calceiformis* occurs only in the form of casts; it is more gibbose, with larger, more elevated umbones, the posterior side being much shorter and more attenuated. As the casts are common, and these distinctive characters are persistent, there can be no doubt that it must be distinguished from the species of Professor Phillips. Authorities generally have followed the 'Geology of Yorkshire,' and placed *Myacites calceiformis* in the Inferior Oolite, and Dr.

Oppel ('Juraformation') has made the Cornbrash shell into a new species, with the name of *Panopea Haueri*; I can, however, with confidence state that there is no evidence that the fossil in question has ever been obtained in Yorkshire lower than the Cornbrash; in Gloucestershire its lowest position is at the base of the Great Oolite.

MYACITES RECURVUM, *Phil.*, sp. Tab. XXXVI, figs. 4, 4 a.

AMPHIDESMA RECURVUM, *Phil.* Geol. York., i, pl. 5, fig. 25.

LUTRARIA SINUOSA, *Roemer.* Ool., tab. 19, fig. 24, Nachtr., p. 42.

PLEUROMYA RECURVA, *Ag.* Et. Crét. Myes., p. 234 et p. 246, t. 29, fig. 9.

LYONSIA RECURVA, *D'Orb.*? Prodr., 12 ét., No. 123.

MYACITES RECURVA, *Mor.* Cat. Brit. Foss., 1854, p. 214.

AMPHIDESMA RECURVUM, *Bean.* Mag. of Nat. Hist., 1839.

MYACITES RECURVUM, *Leckenby.* Proc. Geol. Soc., vol. xv.

*Testa elongato-trapeziformi plano-convexa concentrice striato-rugosa antice brevissima oblique truncata basi perarcuata posterius producta dorso antice sinuatim depressa, margine cardinali postico sinuato, umbonibus crassis incurvis.* (Roemer.)

Shell a lengthened trapeziform, moderately convex, with large, concentric, rugose plications; anterior side very short, obliquely truncated; base curved elliptically; the posterior side produced, compressed, close-fitting; the superior margin somewhat sinuated or concave; the umbones elevated, pointed, and incurved. Usually the anterior side has a furrow, which passes from the umbones downwards perpendicularly or slightly directed forwards to the inferior border, but in some of the more gibbose specimens it cannot be distinguished. The test is delicate; the ornamentation of the surface has the radiating lines of granules so dense and minute, that they can only be distinguished by the aid of a considerable magnifying power. The height is two thirds of the length, the diameter through the valves being equal to half the length. These dimensions apply to the shorter Cornbrash examples, but many of the Kelloway Rock specimens are more elongated. To the latter variety may be attributed the *Lutraria sinuosa*, Roemer; it is necessary, however, to separate altogether the *Lutraria recurva*, Goldf. ('Petref.,' tab. cliii, fig. 15), which has the general figure very different. The example of Agassiz is unusually short and gibbose; and as he has figured a cast, we are precluded from comparing the ornamentation of the surface. D'Orbigny ('Prodrôme,' i, p. 359) has separated it under the title of *Panopea subrecurva*; but, considering the varieties of figure which this species assumes, probably it is only a short variety of the species of Professor Phillips.

*Myacites recurvum* possesses so little of the aspect of a *Gresslya* (*Lyonsia*, D'Orb.) that we are led to speculate upon the probability that *Lyonsia recurva*, D'Orbigny, is a form erroneously ascribed by that author to the species in question.

*Geological Positions and Localities.* *Myacites recurvum* is almost peculiar to the



Oxfordian Oolites; for although it occurs in the Cornbrash of Yorkshire and Wiltshire, it is rarely found in a lower position than the Kelloway Rock. Roemer records his *Lutraria sinuosa* in the Lower Coral Rag of Heersthum; Agassiz places his *Pleuromya recurva* in the Terrain à Chailles of Chamsol, in the department of Doubs.

MYACITES SINISTRA, *Agassiz*, sp. Tab. XXXV, figs. 17, 17 a.

ARCOMYA SINISTRA, *Agassiz*. Ét. Crit. Myes., p. 170, tab. 9, figs. 1—3, et tab. 9', figs. 10—13.

PANOPEA SINISTRA, *D'Orb.* Prodr., i, p. 273.

— — *Oppel*. Juraformation, p. 480.

*Testa ovato-elongata antice attenuata, postice convexa producta, margine hianti, umbonibus subcompressis, depressis, antemedianis, latere antico oblique-declivi, lunula concavo, margine superiori subhorizontali margine inferiore subrecto; valvis lateribus plicis irregularibus crebris longitudinalibus, et sulco superficiali antemediano oblique-declivi. Nucleus glaber.*

Shell ovately elongated, with the sides of the valves rather flattened; anterior side attenuated, its margin sloping obliquely downwards; lunule concave; posterior side more convex and lengthened, its superior border nearly horizontal; the posterior extremity is somewhat rounded, with an aperture moderately large; the umbones are depressed, and somewhat compressed laterally; they are placed a little posterior to the anterior third of the shell, and there is a slight sulcation, which proceeds from them obliquely forwards and downwards towards the lower border; the inferior margin is lengthened and nearly straight; the surface of the test has numerous irregular and rather delicate longitudinal plications; the granules over the greater portion of the valves are so minute and crowded that they cannot be traced to form connecting lines, but towards the sides they are larger, more distantly arranged, and distinctly linear; the test upon the anterior side is of moderate thickness, posteriorly it is much thinner; the nucleus is smooth, and exhibits the adductor and pallial scars.

Length, 2 inches; height, 1 inch; diameter through both the valves,  $\frac{3}{4}$  inch; but our specimen is imperfect, and appears to have lost about 2 lines in length at the posterior extremity.

The more depressed umbones, the anterior attenuation, and the nearly horizontal figure of the superior border, will serve to distinguish it from all the varieties of *Pleuromya elongata*, Ag., to which it bears some resemblance.

The *Arcomya sinistra* of Quenstedt, 'Der Jura,' p. 451, tab. lxii, fig. 2, from the higher stage of the Inferior Oolite, occurs also in the same position in the vicinity of Cheltenham; it is, however, distinct from *Myacites sinistra*. Some varieties of *Myacites decurtatum* approach to it in the general figure, but are readily distinguishable when the granulated



surface can be examined and compared, the minute, crowded pattern upon *M. sinistra*, with the widely separated lines of granules upon *M. decurtatum*.

*Geological Positions and Localities.* The Cornbrash of Scarborough; in the collection of Mr. Leckenby. In Switzerland M. Agassiz records it from the same geological position (calcaire roux-sableux) at Goldenthal, Soleure; also in the Bernese Jura.

MYACITES MODICA, *Bean*, sp. Tab. XLIII, figs. 1, 1 a.

MYA MODICA, *Bean*. Mag. Nat. Hist., 1839.

*Testa-ovato elongata subdepressa, umbonibus subdepressis antemedianis, margine antico producto, rotundo, postico oblique declivi subrecto, margine inferiore elliptico curvato, area ligamenti lanceolata lata, subdepressa, marginibus acutis, valvis lateribus concentricis delicate plicatis; lineis radiantibus granulatis, subtilissimis dense instructis.*

Shell ovately elongated, rather depressed; umbones antero-mesial, rather depressed; anterior margin produced, rounded; posterior margin more lengthened, nearly straight, sloping downwards obliquely, lower border curved elliptically; the granulated test consists of extremely delicate, very densely arranged, radiating lines, visible only under a magnifier; the concentric plications are numerous and faintly traced, so that the surface is smooth; the valves are close-fitting, or have no perceptible aperture at either of the extremities.

Length,  $2\frac{1}{4}$  inches; height,  $1\frac{1}{2}$  inch; diameter through both the valves,  $\frac{4}{5}$  inch.

The general figure and aspect of this species renders it easy to distinguish from other examples of the genus.

*Geological Position and Locality.* The Cornbrash of Gristhorpe Cliffs, in which it has occurred very rarely; Mr. Leckenby's collection.

ANATINA (CEREOMYA) SILIQUA, *Ag.* Tab. XXXV, fig. 15.

SANGUINOLARIA UNDULATA, *Phil.* Geol. York., i, pl. 5, fig. 1, non Sow.

CERCOMYA SILIQUA, *Ag.* Ét. Crit. Myes., p. 148, tab. 11 a, figs. 9—13.

— ANTICA, *Ag.?* Ib., p. 147, tab. 11, figs. 16—18; tab. 11a, figs. 14—16.

ANATINA BELLONA, *D'Orb.* Prod., i, p. 336, 12 ét., No. 132.

— UNDATA, *Id.* Ib., p. 361, 13 ét., No. 221.

SANGUINOLARIA UNDULATA, *Quenstedt.* Der Jura, p. 508, t. 68, fig. 9.

ANATINA UNDULATA, *Leckenby.* Proc. Geol. Soc., vol. xv, 1858.

*Testa transverse elongata inæquilatera umbonibus subanticis parvis acutis, postice*

*rostrata, attenuata, area lata, plicis duobus longitudinalibus; latere antico subcompresso, elliptico curvato, plicisque regularibus et longitudinalibus.*

Shell transversely elongated, very inæquilateral; umbones placed anterior to the middle of the valves, small, depressed, and anterior; posterior side rostrated or attenuated, and much elongated; area large and wide, with two longitudinal ridges, in addition to a distinct marginal ridge which separates the area from the other portion of the shell; anterior side rather compressed, its border is curved elliptically; the anterior portion of the sides of the valves have regular, longitudinal ridges and furrows, which disappear posterior to the umbones; the oblique sulcation which proceeds downwards from the umbones in all examples of *Cercomya* is only faintly impressed.

The specimen figured has the general form of the shell unusually well preserved, but the test has disappeared; the very inequilateral figure, with the attenuation and elongation of the posterior side, will readily distinguish it from *Anatina undulata*, Sow., as also from most other examples of the genus.

Height, one third the length; diameter through both the valves, one fourth the length.

*Geological Positions and Localities.* It occurs rarely in the Cornbrash of Scarborough. Professor Phillips has recorded it in the Oxford Clay, and Mr. Leckenby in the Kelloway Rock and Calcareous Grit of Yorkshire. M. Quenstedt quotes it from the Cornbrash of Wurtemberg; M. Agassiz from the Oxfordian Strata of the Vadois Jura and the Jura of Soleure.

PHOLADOMYA OVULUM, *Ag.* Tab. XXXV, figs. 18, 18 *a*.

PHOLADOMYA OVULUM, *Ag.* Ét. Crit. Myes., p. 119, tab. 3, figs. 7—9; tab. 3 *b*, figs. 1—6.

— — *D'Orb.* Prodr., 11 ét., No. 168, vol. 1.

— — *Morris.* Catal. Brit. Foss., 1854, p. 221.

— — *Oppel.* Juraformation, p. 481.

*Testa ovato-elongata, antice brevior, rotundata, cordata, posterius producta, attenuata, margine inferiore arcuato curvato, superiore subhorizontali, concavo, umbonibus crassis subanticis prominulis; valvis concentricè plicatis, plicis longitudinalibus numerosis inæqualibus mediocriter tenuibus; costellis radiantibus obliquis æqualibus angustis, inferne evanescentibus, apertura postico et antico angusto.*

Shell ovately elongated; the anterior side short, rounded, cordiform; the posterior side produced and attenuated; the inferior margin is curved elliptically; the superior margin is moderately lengthened and concave; the umbones are elevated and tumid; the sides of the valves are convex, with closely arranged but not prominent longitudinal plications; the radiating costæ are very narrow or linear, disposed obliquely, about twelve in number;



they are slightly impressed by the decussating plications, and disappear before reaching the lower border; the apertures, both posterior and antero-inferior, are narrow, and not much lengthened; the post-ligamental area is wide, and bounded by a distinct elevation upon each side.

The test is thin, and is sometimes preserved, the characters of the surface being very well shown upon the casts; in many specimens the radiating lines, or little costæ, are so faintly marked that they are only visible near to the umbones. The very delicate, radiating little ribs and the nearly equally faintly marked longitudinal plications will usually serve to distinguish it from allied forms of the genus when combined with the elongated figure. In the *Pholodomyæ* the relative measurements of the parts are little to be depended upon; but in the Cornbrash specimen figured, the diameter, the height, and the length, are as  $1-1\frac{1}{2}-2$ . Occasionally the length has a greater proportion.

*Geological Positions and Localities.* It is somewhat rare in the Cornbrash of the coast of Yorkshire, but it is common in the Inferior Oolite of the Cotteswold Hills, its position being the stratum with *Conchifera* immediately underlying the bed with *Gryphæa sublobata*.

PHOLADOMYA PHILLIPSII, *Phil.*, sp. Tab. XLII, figs. 2, 2 a.

PHOLADOMYA MURCHISONI, *Phil.* Geol. York., i. pl. 7, fig. 9, non Sow.

— PHILLIPSII, *Morris.* Cat. Brit. Foss., p. 221.

*Testa ovato-cordata, inflata, umbonibus magnis elevatis, antice brevissima truncata, postice producta, valde liante; lateribus rugis irregularibus numerosis, leviter impressis, costisque (7—8) perpendiculariter, angustis; costa secunda majora.*

Shell ovately cordate, much inflated; umbones large, anterior, elevated, but obtuse; anterior side short and truncated; posterior side produced, its superior border concave, with a lengthened, large aperture, which extends upwards even to the ligament; the sides of the valves have very numerous, irregular, longitudinal rugæ, which are not very prominent, and only slightly indent the narrow, perpendicular costæ, of which there are seven or eight; the second costa is much larger than the others, and is more remotely placed, imparting a degree of angularity to the anterior side of the shell; the other costæ are symmetrical, and descend almost perpendicularly to the lower border, leaving a considerable space upon the posterior side of the valves destitute of costæ. The young shell is much less inflated, and more produced upon the posterior side, the aperture at that part being, in proportion, more narrow; the second costa has very little more prominence than the others, so that the anterior side has less angularity and its border is more rounded than in the adult form. In old specimens the height and convexity of the valves are nearly equal, the length being a little more considerable; in young shells, not exceeding an inch and a half in length, the convexity is one third less.



It has only been after long consideration, and an ample comparison of specimens of various dimensions, that I have seen fit to adopt the view taken by Professor Morris in his 'Catalogue,' and separate this shell both from *Pholadomya deltoidea* and from *Pholadomya Heraulti*, of the Inferior Oolite. Compared with the latter form, it will be found that *P. Phillipsii* has the anterior side more truncated, and the posterior side gapes with a larger aperture; this latter feature is, in fact, distinguishable in shells of all dimensions; the longitudinal rugæ are more irregular and much less conspicuous, so that they only slightly indent the costæ, these latter being less oblique than in *P. Heraulti*. The superior largeness and regularity of the rugæ, together with the deep indentations of the costæ, is the feature which, at the first glance, impresses the spectator upon inspecting *P. Heraulti*; the costæ are usually somewhat more numerous, there being two anterior to the large costæ and an additional one posterior to it, so that, together with their greater obliquity, only a small portion of the posterior side of the shell is destitute of costæ.

Compared with *P. deltoidea*, Sow., the figure of the latter is more inflated, the costæ larger and less indented, it also is without the angularity which is imparted by the second large costa of *P. Phillipsii*.

*Geological Position and Locality.* *Pholadomya Phillipsii* is abundant in the Cornbrash of Scarborough, Grinstead, &c., and usually has the test preserved.

PHOLADOMYA DELTOIDEA, Sow. Tab. XLII, figs. 4, 4 a.

CARDITA DELTOIDEA, Sow. Min. Con., t. 197, fig. 4.

PHOLADOMYA MURCHISONI, Sow. Ib., t. 545, the shorter figure only.

— BUCARDIUM, Ag. Ét. Crit. Myes., p. 77, pl. 5, figs. 3—7; pl. 5 a, fig. 8.

— — Chapuis and Dewalque. Fos. Ter. Sec. de Luxembourg, p. 124, pl. 18, fig. 1.

— — Damon. Geol. Weymouth, p. 17, fig. 6.

— SOLITARIA, Mor. and Lyc. Gr. Ool. Moll., part 2, p. 124, tab. xii, fig. 2, et tab. 11, fig. 1.

This species, so abundant in the Great Oolite, Fuller's Earth, and Cornbrash of the south of England, varies greatly in its general figure, even in the same bed and locality; and as its synonyms may now be considered as clearly ascertained, I have deemed it desirable to figure a specimen from the Cornbrash of Wiltshire, in which the costæ are irregularly arranged, and the general figure is more lengthened than in the two specimens formerly figured in the second part of the 'Monograph of the Great Oolite Mollusca,' under the name of *P. solitaria*. Of these latter, the index facing Tab. XII, fig. 2, by a typographical error, was printed *P. oblita*, a shell which is given at fig. 5 upon the same plate. Even the two Great Oolite specimens have the anterior side less truncated, the

umbones more obtuse, and the general figure less inflated, than obtains in the greater number of those from the Minchinhampton district; and, upon the other hand, all of them are less lengthened upon the posterior side than is seen in the figures given by Agassiz and by Messrs. Chapuis and Dewalque.

*Pholadomya deltoidea* is remarkable for the large, prominent, and slightly indented costæ, usually seven in number, of which the two posterior ones are much less conspicuous, and are usually evanescent towards the lower border.

The frequent truncation of the anterior side in *Pholadomya*, and the general distortion of the shell which usually accompanies it, is a source of frequent difficulty in the discrimination of species, and is seen commonly and even usually in *P. deltoidea*, when specimens are collected without selection. The shell in its normal position rested upon the compressed anterior side; the general distortion of figure consequent upon it commenced at a very early period in the growth of the mollusc, continued throughout its existence, and did not prevent it from attaining to the usual dimensions of the species; it occurs equally in all the other forms assumed by the genus. Where the flattening of the anterior side is considerable the umbones become more pointed and prominent, the radiating elevations or ribs are directed more obliquely backwards; in other instances they become more closely arranged, or they are waved and irregular. The distortion is not limited to specimens connected with any particular kind of lithological condition, as it occurs in compact, thin-bedded limestones, in thick beds of soft, sandy marl, or in thick-bedded Oolitic limestone; it is also common to find both compressed and uncompressed examples in contiguity.

PHOLADOMYA LYRATA, Sow. Tab. XLIII, figs. 3, 3 a.

CARDITA ? LIRATA, Sow. Min. Con., t. 197, fig. 3.

PHOLADOMYA LYRATA, Sow. Ibid., p. 220.

— — Oppel. Juraformation, p. 482.

*Testa obovato-trigona, ventricosa, umbonibus elevatis antero-medianis, latere antico truncato, postico oblique declivi, costis 9—10, tertia majora, carinam efformante, costis aliis approximatis, plicis magnis concentricis regularibus indentatis; apertura postica angusta, elongata.*

The figure is nearly that of a cone, compressed laterally; the umbones are elevated, pointed, and placed a little anterior to the middle of the valves; the steepness and straightness of the posterior slope, together with the nearly straight lower border, imparts a distinctive character to the shell, irrespective of the large, carinated third costa, which is so much more conspicuous than the others that it forms a kind of keel or angle upon the anterior side; it descends to the lower border without curvature, but is directed slightly



forwards; the six or seven costæ posterior to it are much smaller, they diminish regularly in prominence, are closely arranged, and are deeply indented by the regular, large, concentric plications; the anterior side gapes slightly, and has two inconspicuous, indented costæ; the posterior aperture is narrow and lengthened.

The sub-conical figure, pointed posterior side, and large, carinated rib, will serve to distinguish it from *P. Heraulti*, Ag., to which it is nearly allied; the more angulated figure, and more numerous costæ, from *P. carinata*, Ag. Some examples of *Pholadomya* from the Inferior Oolite are not distinguishable from *P. lyrata*; but between these and *P. Heraulti* are others, which apparently serve to connect the two forms, so that it is difficult to separate them altogether from *P. lyrata*, although undoubtedly they must be merged with *P. Heraulti*; these connecting links are also quite irrespective of any changes that may be due to the stage of growth in either of the two species.

*Geological Positions and Localities.* *P. lyrata* is common in the Cornbrash of Wiltshire and Dorsetshire. Dr. Oppel records it in the same rock at Marquise, near Boulogne, and Egg, near Aran. D'Orbigny ('Prodrôme,' i, p. 252) quotes it from the Upper Lias, near Bath, which is an error copied from the 'Mineral Conchology of Great Britain.'

*HOMOMYA GIBBOSA*, Sow., sp. Part II, Tab. XII. fig. 14; Tab. XLIII, figs. 2, 2 a.

Described at page 138, Part II, under the name of *Myacites gibbosus*. As this shell occurs abundantly both in the Cornbrash and the Inferior Oolite of the southern counties of England, a full-sized average example is here figured; occasionally, indeed, the species acquired much larger dimensions, as in the Cornbrash of Wiltshire, but it is then invariably more or less distorted and imperfect; it is also more gibbose than the smaller examples. Since the publication of the former portions of this Monograph more extended information respecting this and other allied species comprised in the proposed genus *Homomya* of Agassiz has led to the conclusion that they cannot be assigned to the genus *Myacites*, of which they possess neither the external granulated tegument nor the peculiar characters of the hinge.

When the surface of *Myacites* has been denuded of the granulated tegument it is smooth, with irregular, longitudinal laminæ, whereas *Pholadomya* and *Homomya* have a wrinkled or corrugated surface.

The genus *Homomya* was intended by Agassiz to include shells whose forms resemble those of the more lengthened *Pholadomyas*, but which are destitute of radiating costæ, and have usually a thicker test, the hinge being identical with that of *Pholadomya*, usually, indeed, more massive; but although the sides of the valves are destitute of costæ, it occasionally happens that a few delicate, radiating lines, more or less obscurely marked, are visible upon the umbones, but vanish before they reach the middle of the



valves. Examples of this are supplied by the large Liassic *Homomya ventricosa*, Ag., by *Homomya Vezelayi*, D'Arch., and by *Homomya crassiuscula*, Mor. and Lyc. The hinge of the latter shell exhibits its perfect identity with that of *Pholadomya*. It is therefore evident that *Homomya* cannot claim a generic separation; but that, viewed as a subgenus or section of *Pholadomya*, the name may conveniently be retained. *Myacites Vezelayi*, page 111, and *Myacites crassiusculus*, page 112, should therefore also be removed to *Homomya*.

HOMOMYA CRASSIUSCULA, Mor. and Lyc. Tab. XLIII, figs. 5, 5 a.

A small example from the Great (?) Oolite of Lincolnshire was figured, Part II, Tab. XI, fig. 3. As the species occurs of full dimensions in the Cornbrash of Scarborough, a specimen, with the test preserved, is here given.



## ADDENDA.

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A PORTION of the text of this Supplement passed through the hands of the printer long prior to the execution of the plates; and during this lengthened interval many additional testacea were placed at the disposal of the author, including a considerable series from the Forest Marble of the counties of Wilts, Somerset, and Dorset, which had recently been disengaged from the investing matrix by the exertions of W. Walton, Esq., of Bath, obtained by that gentleman, and by the late John Kilvert, Esq., of the same place. This fine collection has yielded many new forms, and also some superior examples of others that had previously been figured from specimens less suitable for the purpose; advantage has been taken of the opportunity thus afforded to give additional illustrations. The descriptions of the more recently acquired fossils could not, therefore, for the most part, be placed in their proper order, and necessarily form *Addenda* to the Supplement.

CERITHIUM (?) HEMICINCTUM, *Lyc.* Tab. XLI, fig. 17.

*Testa parva, elongata, anfractibus (7), valde convexis, postice subplanis, lævigatis, antice tricinctis, convexis, anfractu ultimo basi concentrice striato. Apertura et canali ignota.*

Shell small, elongated; volutions (7) very convex, their posterior portions oblique, flattened and smooth, their anterior portions with three prominent encircling costæ, the sutures are deeply constricted; the last volution has the base concentrically sulcated; the outer lip and the base are imperfect; the genus, therefore, is somewhat uncertain; there are some traces of an umbilical opening at the base of the columella.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.



CERITHIUM (P) NEGLECTUM, *Lyc.* Tab. XLIV, fig. 21.

*Testa parva, subulaba, anfractibus (circa 7) subplanis, longitudinaliter costatis, costis (5), magnis, depressis, subobliquis, a sinistro ad dextrum versus, apertura parva, canala (P).*

Shell small, subulate; volutions (about seven) flattened, with five longitudinal large, depressed, and smooth costæ, which are directed somewhat obliquely from left to right, and are slightly interrupted by the sutures; the aperture is small and depressed, the canal is imperfect.

The extremities of the costæ do not always exactly accord with those of the next volution, which gives some irregularity to the appearance of the volutions; no traces of encircling striations are visible.

The spire is not angulated as in *C. pentagonum*, the subulate figure and plain surface distinguishes it from *C. sexcostatum*.

*Geological Position and Locality.* The Great Oolite of Bussage; collected by E. Witchell, Esq.

CERITHIUM COSTIGERUM, *Piette.* Tab. XLI, figs. 11, 11 a, b.

*Testa inflata, subcylindrica, anfractibus (7—9), costis (12) rectis, angustis, elevatis, postice acuminatis, lineisque transversalibus, instructis; apertura parva, canali recto, elongato.*

Shell somewhat inflated and subcylindrical, volutions (7 to 9) with the sides perpendicular, costæ (12) perpendicular, narrow, and much elevated, terminating posteriorly each in a projecting point, anteriorly they bend inwards slightly to the suture, there are also regular encircling lines; the base is smooth, the aperture is small, the canal lengthened and straight.

There is much variability in the elevation of the spire, and, consequently, in the height of the volutions; a specimen more than usually lengthened has the costæ somewhat oblique.

*Geological Positions and Localities.* The Forest Marble of Laycock; in the collection of W. Walton, Esq. It is recorded by M. Piette in the Great Oolite Limestones of Eparcy and Rumigny.

CERITHIUM (P) WALTONI, *Lyc.* Tab. XLI, fig. 16.

*Testa parva turriculata anfractibus numerosis angustis, inflatis, saturis bene impressis, costis rectis angustis, elevatis (circa 11) in ambitu lineis regularibus cingendis; apertura et canali ignota.*

Shell small, turreted, volutions numerous (8—9), narrow, inflated, the sutures deeply impressed; costæ (about 11 in the circumference) perpendicular and narrow, crossed by a few regular encircling lines. The aperture and canal are imperfect.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

CERITHIUM (?) POCULUM, *Lyc.* Tab. XLIV, fig. 24.

*Testa parva, subcylindrica, anfractibus (9) lævigatis, postice expansis et profunda canaliculatis, antice contractis; apertura parva, canali contracto et contorto.*

Shell small, subulate, subcylindrical, volutions (about 9) smooth, expanded posteriorly and deeply channelled, contracted anteriorly, the aperture is small, the canal is produced, narrow, and twisted.

The genus is somewhat doubtful, additional specimens may prove it to be a *Nerinea*.

*Geological Position and Locality.* The Great Oolite of Bussage, near Bisley Common; collected by E. Witchell, Esq.

CERITHIUM EXSCALPTUM, *Lyc.* Tab. XLIV, fig. 23.

*Testa parva, subulo-elongata, anfractibus (10) angustis, sub-planis, transverse tenuissime striatis, anfractu ultimo rotundo, canali brevi, sub-recto.*

Shell small, subulately turreted, pointed, volutions (10) slightly convex, narrow (two and a half times as wide as high), with numerous very delicate encircling striations, the last volution has the base rounded, the canal is short and nearly slight.

Obtained by crushing the white stone for the Great Oolite for minute Gasteropoda.

*Geological Position and Locality.* The Great Oolite of Bussage; collected by E. Witchell, Esq.

#### KILVERTIA, *Gen. Nov.*

*Testa elongata, sub-cylindrica, anfractibus numerosis, perpendiculariter costatis tuberculatis aut spinosis; anfractu ultimo cylindrico, basi sub-contracto; apertura integra, rotundata aut ovali, labris protractis, tenuiter incrassatis, non nunquam sub-undulatis, columella solida.*

Shell elongated, sub-cylindrical, sometimes somewhat pupæform; volutions numerous,

perpendicularly costated, tuberculated or spined; the last volution cylindrical, sometimes contracted at the base; aperture entire, orbicular or ovate, the lips elevated, produced and slightly thickened, sometimes undulated, columella solid.

Allied to *Cerithium*, *Potamides*, *Turritella*, *Omphalia*, *Rissoa*, and *Aclis*; from the two former it is separated by the absence of an anterior and posterior canal, the thickened and produced margins of the aperture distinguish it from *Turritella*, and from the *Omphalia* of Zekeli, from *Omphalia* more especially by the absence of a sinus or fissure of the outer lip, from *Rissoa* by the many-whirled figure and produced lips, from *Aclis* by the costated or spined volutions, cylindrical last volution, and produced aperture.

The Great Oolite species obtained in the Minchinhampton district are always small and sometimes minute, these are *Cerithium* (?) *spiculum*, Lyc., p. 9; *C.* (?) *strangulatum* D'Arch., p. 8; *C.* (?) *pulchrum*, Lyc., p. 10, of which latter species very fine and large examples occur also in the Forest Marble clays of Laycock, accompanied by *Kilvertia formosa*, Lyc. Other examples, known only in foreign localities, are *Rissoa* (?) *elegantula*, Piette, from the Great Oolite of Eparcy; *Cerithium angistoma*, *C. quinquangulare* and *C. pupoides*, Hebert and Deslongchamps, from the Kelloway Rock of Montreuil-Bellay; *Scalaria* (?) *minuta* and *Cerithium pygmeum*, Buvignier, from the Calcaire à Astartes of the department of the Moselle. In selecting a name for this proposed genus, I have much pleasure in adopting the suggestion of Mr. Walton, and dedicate it to the memory of the late John Kilvert, Esq., of Bath, whose researches in the Palæontology of the Jurassic rocks of the southern counties resulted in the acquisition of a fine and instructive collection of the Mollusca.

KILVERTIA PULCHRA, *Lyc.* Tab. XLIV, fig. 4; Tab. XLI, figs. 12, 12 *a*.

CERITHIUM? PULCHRUM, p. 10, of this Supplement.

The fine collection of Forest Marble shells forwarded by the kindness of Mr. Walton, contains many specimens of this *Kilvertia* which exhibit much variability in their ornamentation, and are upwards of three times the linear dimensions of the Minchinhampton examples; the Laycock shells having been obtained by washing layers of clay and shale; there is an entire absence of that abrasion of the surface to which oolitic fossils have so frequently been subjected; additional figures of this fine species will be found Tab. XLI, figs. 12, 12 *a*. The figure of the aperture in shells of the same size also presents some variability, the typical suborbicular figure becomes sub-quadrate, and in other instances is somewhat pointed at the two extremities, but in the young condition apparently the aperture is always orbicular.



KILVERTIA FORMOSA, *Lyc.* Tab. XLIV, fig. 5.

*Testa parva subulo-pupæformi, anfractibus (6 ?) latis, planatis, suturis bene distinctis, costis longitudinalibus rectis (circa 7 in ambitu) rotundis, depressis, inferne evanescentibus; lineis transversis (circa 7) regularibus, elevatis; apertura parva suborbiculari, labris integris, simplicibus.*

Shell small, elongated, pupæform or lessening at both the extremities, volutions (6?) wide, flattened or very slightly convex, the sutures well impressed, aperture small, suborbicular; the lips continuous without undulation; longitudinal costæ (about 7) straight, rounded, and but slightly elevated, indistinct upon the latter volutions, knotted where they are crossed by encircling lines, of which each volution has about seven, regular and conspicuous; the costæ are not continuous, neither do their extremities exactly correspond at the sutures of the successive volutions, they are more prominent upon the upper half of each volution; the apex is imperfect, the first volution having disappeared.

Allied to *Kilvertia strangulata* = *Cerithium strangulatum*, D'Arch., from which it is distinguished by the smaller dimensions, the greater elongation of the spire, and by the costæ, which are much smaller, more depressed, and do not form continuous elevations.

*Geological Position and Locality.* Collected by E. Witchell, Esq., in the white (Great) Oolite of Bussage, near Bisley Common.

AMBERLEYA CAPITANEA, *Goldf.*, sp. Tab. XLI, fig. 1.

Part I, p. 65, contains a correct description of this species (*Turbo capitaneus*, Goldf.), which is not uncommon in the Supra-liassic sands and the Inferior Oolite of the southern counties; Mr. Walton has also forwarded two small examples obtained in the Forest Marble of Laycock, and of Pound Pill. The shell figured Tab. IX, Part I, fig. 33, was referred doubtfully to this species, of which it was supposed to be a badly preserved example; subsequent examinations of other specimens from the same locality have proved that this view was erroneous, and that it is a distinct species; a description of this latter shell will be found in this Supplement (p. 19) under the title of *Amberleya Jurassi*.

AMBERLEYA MONILIFERA, *Lyc.* Tab. XII, fig. 10.

*Testa parva, ovato-elongata, spira alta, acuta, anfractibus (4—5) in medio carinatis, tabulo-nodiferis, postice et antice concavis, ejusdem carina parva, nodifera; anfractu ultimo basi sulcis quinque, concentricis, apertura antice subcontracto.*

Shell small, ovately elongated, spire elevated, acute, consisting of four or five volu-

tions, which have a prominent encircling nodiferous carina in their middle portion, their posterior and anterior surfaces being concave, each having a small nodiferous carina; the last volution has at its base fine encircling sulcations; the aperture has the anterior extremity rather pointed.

The tubercles upon the mesial carina are large, projecting slightly forwards, very closely arranged and tubular, about eighteen in a volution, the anterior and posterior carinæ have similar tubercles, but much smaller. The height of the shell is one third greater than the opposite measurement.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

AMBERLEYA TRICINCTA, *Lyc.* Tab. XLI, fig. 14.

*Testa ovato-elongata, anfractibus (8—9) turbinatis, inferne angulatis, cingillis, tribus, lineis perpendicularibus decussatis, anfractu ultimo, lineis magnis concentricis; apertura pyriformi.*

Shell ovately elongated, volutions (8—9 turbinated, angulated towards their lower portions, and flattened or slightly convex above the angle, the sutures are strongly marked, encircling lines three, of which one is above and another beneath the angle; these are decussated by other lines perpendicular and smaller, forming tubercles more or less distinct where they cross the angle, the decussating lines are distantly and sometimes irregularly arranged; the last volution has large, regular, concentric elevations; the aperture is pyriform.

An elegantly turbinated more or less lengthened shell, with convex volutions and a delicately ornamented surface; about a dozen specimens have been compared, which do not vary much in size; the length of the aperture is about two fifths of the entire shell. All the examples are more or less imperfect at the base.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

NATICA TEXATA, *Lyc.* Tab. XLV, figs. 30, 30 a.

*Testa ovata, depressiuscula, crassa, spira anfractibus (3) patens, vix elevatis, convexis; anfractu ultimo inflato, basi umbilicato, apertura subreniformi, labro interno crasso; superficie striis vel lineis textatis delicatissimis ornata.*

Shell ovate, depressed, thick, spire consisting of three depressed but exposed and rounded volutions, the last volution much inflated, the base umbilicated, the aperture somewhat reniform, the inner lip thick and conspicuous; the surface with very delicate encircling lines or striations, which are rendered granular by others decussating them.

Allied to *Natica Montreuilensis*, Heb. and Desl., from the Kelloway Rock of Montreuil-Bellay, which species, however, is less depressed and the aperture more lengthened.

The ornamentation of the surface in our shell is partially preserved, and can only be perceived by the aid of magnifying power.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

*NATICA ARATA.* Tab. XLV, fig. 2.

*Testa parva, crassa, inflata, spira exserta, anfractibus (4) convexis, ultimo, permagno, transverse striato, suturis valde impressis, apertura ovata, umbilico nullo.*

Shell small, thick, inflated, spire produced, volutions (4) convex, the last volution very large and globose, with delicate encircling striations, the sutures deeply impressed, the aperture is ovate; there is no umbilicus.

*Geological Position and Locality.* The Great Oolite of Bussage; collected by E. Witchell, Esq.

*NATICA (EUSPIRA) ALTA, Lyc.* Tab. XLV, figs. 22, 22 a.

*Testa parva, lævigata, subglobosa, spira elongata, apice acuto, anfractibus (4) convexis, latis, suturis valde impressis, anfractu ultimo permagno, subgloboso, apertura ovata, obliqua, subumbilicata.*

Shell small, smooth, spire elevated, its apex pointed, volutions (4) convex, moderately wide, the sutures strongly marked, slightly constricted, the last volution very large, subglobose, the aperture ovate, oblique, the inner lip prominent, the base with an umbilical groove. The height of the aperture is slightly greater than that of the other portion of the shell. Perhaps this is the young condition of a much larger species.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

*NATICA INSIGNIS, Lyc.* Tab. XLV, fig. 21.

*Testa parva inflata, spira elevata, acuta, anfractibus (7) convexiusculis, angustis, suturis bene impressis, anfractu ultimo permagno, subgloboso, apertura ovali, umbilico nullo.*

Shell small, inflated, spire much elevated, its apex acute, volutions (7) moderately convex, narrow, the latter two volutions increasing rapidly, and becoming much inflated, the last volution is very large, subglobose, the aperture rather depressed, ovate, with no distinct umbilicus, or with a slight groove.



The unusual number of the volutions and the sudden inflation of the last volution renders its discrimination easy.

The height is about equal to the transverse diameter of the last volution.

*Geological Position and Locality.* Collected by E. Witchell, Esq., in the Great Oolite of Bussage, near Bisley Common; it has also occurred rarely in the Cornbrash of Scarborough.

*RISSOINA SUBULATA, Lyc. Tab. XLI, fig. 9.*

*Testa elongata, subcylindrica, anfractibus (9) convexis, altis, longitudinaliter oblique costellatis, costellis, crebris (circa 30 in ambitu), apertura ovato-obliqua, parva.*

Shell elongated, subcylindrical, volutions (9) convex, high, longitudinally obliquely costellated, costellæ closely arranged (about 30) in a volution; aperture ovate, oblique, small.

A slender, subulate, delicately ornamented shell; the height of the volutions is equal to three fourths of their opposite diameter.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

*RISSOINA (?) TUMIDULA, Lyc. Tab. XLIV, fig. 13.*

*Testa ovato-tumidula lævigata, spira elevata, anfractibus (5) convexis, latis, suturis bene distinctis, apertura ovata, antice angulata, labro externo crasso.*

Shell ovate, inflated, smooth; spire short, but elevated; volutions (5) convex, wide, their sutures deeply impressed; aperture ovate; the outer lip thick, forming an angle at its junction with the base of the columella. There is no distinct notch.

A short, inflated species, resembling in the figure of the aperture *R. lævis*, Sow., both seeming to constitute aberrant examples of *Rissoina*, and approximating to *Rissoa*.

*Geological Position and Locality.* Collected by E. Witchell, Esq., in the Great Oolite of Bussage, near to Bisley Common, Gloucestershire.

*NERITA CLAVATULA, Lyc. Tab. XLV, fig. 3.*

*Testa hemispherica, spira parva, subdepressa, anfractu ultimo permagno, inflato, tuberculis parvis, remotiusculis, per series quinis, regularibus, et lineis radiantibus, tenuibus, decussatis; basi carina una, lævigata.*

Shell hemispherical; spire small, obtuse, and rather depressed; the last volution very

large, inflated, with small depressed tubercles, rather remote, and arranged in fine encircling rows, the rows of tubercles are connected by delicate radiating lines, one of which is united to each tubercle; the base has a single, smooth, encircling keel; the aperture and inner lip are similar to those of *Nerita minuta*.

A pretty little and rare species, with the tubercles rather distantly arranged in each row, they are somewhat lozenge-shaped or pointed posteriorly, about fourteen occupying an entire volution.

*Geological Position and Locality.* The Great Oolite of Bussage, adjoining Bisley Common, in the bed of white stone; collected by E. Witchell, Esq.

**TROCHUS BURTONENSIS, *Lyc.* Tab. XLV, fig. 16.**

*Testa conica, lævigata, spira elevata, anfractibus (6), postice planatis antice concavis et obtuse angulatis, anfractu ultimo basi leviter convexa, imperforata, apertura subrotunda, columella basi dente callosa.*

Shell conical, smooth; spire elevated; volutions (6), their posterior portions flattened, the anterior portions concave, bounded by an obtuse carina, the last volution has the base slightly convex, imperforate, but with an umbilical depression; the aperture is rounded; the base of the columella has a thickened dental process. Small specimens have the spire less elevated, and the bounding carina much less prominent.

*Geological Position and Locality.* The Forest Marble of Burton Bradstock; in the collection of W. Walton, Esq.

**TURBO DEPAUPERATUS, *Lyc.* Tab. XLV, fig. 13.**

PLEUROTOMARIA PAGODUS, var. DEPAUPERATA, Gr. Ool. Mon., Pal. Soc., 1850, part 1, pl. 10, fig. 9, p. 77.

The shell figured in the first part of this Monograph as a doubtful variety of *Pleurotomaria pagodus*, Desl., has, by the aid of other specimens, been clearly shown to be a different shell, which does not belong to the genus *Pleurotomaria*. Very few examples have hitherto been obtained, all of which are more or less imperfect, have suffered compression, or have been indifferently preserved; however, by comparing one with another, the distinctive characters have been fully ascertained.

A Forest Marble specimen, slightly compressed, is now figured; compared with the original of the former figure the spire is less elevated, the ornamentation of the surface and of the base are better preserved.

The description formerly given applies to the species of Deslongchamps, the following to *Turbo depauperatus*.

*Testa turbinata, spira elevata, apice obtuso, anfractibus (5) convexis, imprimis inornatis,*

*anfractu ultimo et penultimo in medio angulato, costis subnodulosis cingendis, angulo tuberculis regularibus depressis coronatis; basi striis concentricis et radiantibus decussatis, umbilico patens, angulato, concentrice striato; apertura depressa, sublunulata.*

Shell turbinated; spire elevated, its apex obtuse; volutions (5), of which the first three are rounded and without ornamentation, the two latter enlarge rapidly, are angulated in their middle, and coronated with a row of regular depressed encircling tubercles, above and beneath the angle are also three or four rows of nodulous encircling costæ, of which those beneath the angle are the most prominent; the base is slightly convex, concentrically and radiately striated; there is an open umbilicus encircled by an angle, and concentrically striated; the aperture is depressed and sublunulate.

The last volution has the surface above the angle much flattened, and rendered rugose by the nodulous elevations; the encircling costæ are closely arranged, somewhat irregular, and become smaller towards the base of the last volution. In the specimen figured the outer lip is imperfect.

*Geological Positions and Localities.* The Forest Marble of Laycock and Pound Pill; in the collection of W. Walton, Esq.

**TURBO BURTONENSIS, Lyc.** Tab. XLV, fig. 15.

*Testa turbinata, spira elevata, anfractibus (4) convexis, cingillis tuberculosi tribus magnis instructis; ultimo anfractu basi cingillis (3 aut 4); apertura ovata, umbilico nullo.*

Shell turbinated; spire elevated; volutions (4) convex, each encircled by three rows of closely arranged large tubercles; the last volution has at the base three or four concentric rows of smaller tubercles; the aperture is ovate; there is no umbilicus.

The upper part of each volution is somewhat flattened, upon which is one row of tubercles, the other two rows are more closely arranged; the tubercles are large and obtusely rounded. The basal transverse diameter is one fourth greater than the height. It is allied to *Turbo muricatus*, Sow., but with a shorter spire, more constricted sutures, and the tubercles much larger.

*Geological Position and Locality.* The Forest Marble of Burton Bradstock; in the collection of W. Walton, Esq.

**TURBO SUBTEXATUS, Lyc.** Tab. XLI, figs. 15, 15 a.

*Testa parva, inflata, spira elevata, anfractibus valde convexis, postice subhorizontalibus, antice convexis, suturis profunde impressis, anfractu ultimo permagno, apertura ovali, umbilico nullo; superficie lineis concentricis et longitudinalibus tenuissimis, aut punctis vix notatis.*



Shell small, inflated ; spire elevated ; volutions (4) very convex, their posterior portions nearly horizontal, their anterior portions convex, with the sutures deeply impressed ; the last volution very large and ovate ; the aperture oval, no umbilical depression ; the surface, with lines encircling and perpendicular, very densely and irregularly arranged, having sometimes an imperfectly punctated aspect.

It is allied to *Turbo gibbosus*, D'Orb., but the latter is shorter and more inflated.

*Geological Position and Locality.* The Forest Marble of Farleigh ; in the collection of W. Walton, Esq.

MONODONTA COMMA, *Lyc.* Tab. XLV, figs. 24, 24 a.

*Testa ovato-discoidea, anfractibus (4), elevatis, subplanis, suturis distinctis, anfractu ultimo magno, apertura elliptica, umbilico parvo, dente basali magno obtuso ; superficie striis concentricis tenuissimis, regularibus.*

Shell ovate, discoidal ; spire elevated ; volutions (4) rather flattened, apex obtuse ; the sutures distinct ; the last volution large, rather depressed, aperture elliptical ; umbilicus small ; basal tooth large, obtuse ; the surface has very delicate, closely arranged, regular encircling striations.

The general figure nearly approaches to *Monodonta* (*Crossostoma*) *heliciforme*, but the latter shell is without ornamentation, and has a smaller and more depressed basal tooth and sulcus.

*Geological Position and Locality.* The Forest Marble of Farleigh ; in the collection of W. Walton, Esq.

MONODONTA WALTONI, *Lyc.* Tab. XLV, figs. 31, 31 a, b.

*Testa crassa, ovoidea, tenuissime concentrice striata, spira brevi depressa, suturis distinctis, anfractibus (5) angustis, subconvexis, anfractu ultimo permagno ; basi obliquo subumbilicato, dente et sulco magno obtuso ; apertura ovata.*

Shell thick, ovoidal, delicately concentrically striated ; spire short, depressed ; volutions (5) narrow, slightly convex, their sutures distinct, the last volution very large, base oblique, and slightly umbilicated ; the basal tooth and sulcus prominent ; aperture ovate, outer lip thick.

A pretty little delicately ornamented species, of twelve examples the smallest is scarcely larger than the head of a pin, and has a distinct umbilicus ; the largest has a diameter of four lines.

*Geological Position and Locality.* The Forest Marble of Farleigh ; in the cabinet of W. Walton, Esq.

MODODONTA ARATA, *Lyc.* Tab. XLV, fig. 19.

*Testa trochiformi, spira elevata, anfractibus (6) latis, concavis, postice et antice carina, striata, obtusa, suturis valde impressis, anfractibus semel concentricè tenuissime lineatis et decussatim oblique striatis; basi lineis concentricis majoribus et minoribus alternatis; sulco columellari magno et dente obtuso.*

Shell trochiform; spire elevated; volutions (6) wide, concave, having a striated obtuse keel upon their posterior and anterior borders; there are also very delicate encircling lines, which are indented by oblique decussating striations; the base is concentrically lineated, the lines being alternately large and small; there is also a conspicuous columellar groove and obtuse tooth; the aperture is nearly circular.

Height and basal diameter nearly equal.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

MONODONTA TEGULATA, *Lyc.* Tab. XLV, figs. 17, 18.

*Testa sub-trochiformi, spira elata, anfractibus (4), latis, in medio angulatis, carinis, tribus cingendis, superne oblique planatis, inferne concavis, anfractibus semel concentricè lineatis, lineis granosis, striis tenuissimis decussatis; basi concentricè lineatis, sulco magno umbilicali et sulco et dente obtuso instructo.*

Shell sub-trochiform; spire elevated, consisting of four wide and carinated volutions, angulated in their middle portions by a prominent encircling keel, a keel being also placed at the anterior and posterior border of each volution; between the carinæ are numerous regular encircling lines, rendered granulated by decussating very fine oblique striations; the base is concentrically lineated, and has a large umbilical groove bounded by a prominent keel; the columellar sulcus and tooth are also conspicuous; the aperture is subcircular, its outer border impressed by the carinæ.

The diameter at the base is one third greater than the height. A pretty species, with strongly sculptured ornamentation. The volutions are obliquely flattened above and concave beneath the median carina.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

*Genus—ONUSTUS, Humphrey.*

Shell conical, with several volutions, which are flattened or are rendered somewhat concave by an expansion of their lower borders, which overhang and conceal the suture; the lower border of the last volution is produced horizontally to support a membranous expansion; the surface has striations, or radiately undulating lines, which are somewhat irregular. The base is concave towards the outer border, and convex towards the centre; the umbilical orifice is sometimes large, but in other instances small, and becomes nearly concealed by advance of growth; the aperture is depressed and ovate. Some Tertiary and Recent species have the spire encrusted with fragments of shells or stones, which obscure the ornamentation.

*Xenophora*, Fischer, and *Phorus*, Montfort, are synonyms of this genus.

**ONUSTUS BURTONENSIS, Lyc.** Tab. XLV, figs. 7, 7 a, b.

*Testa subconica, spira elevata, obtusa, anfractibus (4-5), angustis subconcavis, longitudinaliter costatis, costis (circa 24—26) inferne alternatim in spinis producta; basi subconcavo, concentrice et radiatim striato, umbilico amplo.*

Shell subconical, wider than high; spire moderately elevated obtuse; volutions four or five, narrow, slightly concave, with about twenty-four to twenty-six longitudinal rounded and elevated costæ; the base of every alternate costa forms, with the lower expanded margin of each volution, a projecting process, which renders the lower margins of the volutions undulated; the base is expanded, slightly concave, concentrically and radiately striated; the umbilicus is large.

A pretty species, possessing the generic features strongly defined, more especially the expansions at the lower border of each volution, which impart a pagoda-like aspect to the spire. Only two other British Jurassic species are known, viz, *Trochus pyramidatus*, Phil., = *Trochus lamellosus* D'Orb., a more depressed species, which occurs in the Supra-Liassic sands, and in the Inferior Oolite of Gloucestershire and of Yorkshire; the other is the *Trochus ornatissimus*, D'Orb., with a very elevated spire, and inordinately expanded at the lower border; it occurs in the Inferior Oolite of the Cotteswolds, and in the White Oolite of Ponton, Lincolnshire. Our species is most nearly allied to *Trochus ornatissimus*, but with a shorter spire, fewer volutions, and with prominent overwrapping expansions at the lower border of each volution. Other foreign Jurassic species are *Trochus heliacus*, D'Orb., *T. Tytirus*, D'Orb., *Solarium callaudianum*, D'Orb., *Onustus exul*, Eug. Desl., and *Onustus liasinus*, E. Desl. None of these species exhibit those agglutinations of shells and stones which are so characteristic of the Tertiary and Recent examples of *Onustus*.



*Geological Position and Locality.* The Forest Marble of Burton Bradstock ; in the collection of W. Walton, Esq.

PHASIANELLA VARIATA, *Lyc.* Tab. XLV, figs. 28, 28 *a*, *b*.

*Testa ovato-elongata, spira acuta, anfractibus (6-7), subconvexis, latiusculis, suturis valde impressis, ultimo anfractu amplo, apertura obliqua, ovato-elongata.*

Shell variable in figure, ovately elongated ; spire lengthened, with the apex acute ; volutions six to seven, wide, more or less convex ; the sutures strongly impressed ; the last volutions conformable, the aperture oblique, ovate, narrow, but always less than half the height of the shell.

The variability in the convexity of the volutions and their height is considerable. The general aspect resembles *P. elegans*, Mor. and *Lyc.*, in which the spire is always less pointed and less slender, the last volution being also longer.

*Geological Position and Locality.* The Forest Marble of Laycock ; in the collection of W. Walton, Esq.

SOLARIUM TURBINIFORMIS, *Lyc.* Tab. XLV, figs. 23, 23 *a*, *b*.

*Testa turbinata, spira dextra, elevata, obtusa, anfractibus (4), tuberculis numerosis, coronatis ; basi convexa, umbilico magno, margine, nodis (circa 9) cingendo, superficie lineis transversalibus et longitudinalibus decussatis ; apertura suborbiculari.*

Shell turbinated, spire dextral, elevated, volutions four, their borders coronated with a circle of tubercles, about eighteen in a volution ; the base is convex, with a large and deep umbilical cavity, bordered by large nodose elevations, about nine in the volution ; the aperture is suborbicular ; the entire surface has encircling lines, with more narrow interstitial spaces decussated and rendered granular by densely arranged transverse striations.

Allied to *Straparollus altus*, D'Orb. ; the latter species, however, has the last volution more elevated and the sides much more flattened, which impart a subquadrate figure to the aperture ; the nodose elevations encircling the umbilicus are also fewer and larger.

*Geological Position and Locality.* The Great Oolite of Hampton Cliffs ; in the collection of W. Walton, Esq.

SOLARIUM WALTONI, *Lyc.* Tab. XLV, figs. 26, 26 *a*, *b*, *c*.

*Testa discoidea, latere superiori et inferiori concavo, dorso angusto, convexo, tuberculis per series duobus instructis ; latere superiori anfractibus subconcavis, varicibus obscuris*

*transversalibus instructis; latere inferiore anfractibus planatis; lineis transversalibus et longitudinalibus cancellatis; apertura subquadrata.*

Shell discoidal, the superior and inferior sides concave, the back narrow, rounded, encircled upon its upper part by two rows of tubercles, of which there are about nineteen in a volution; the upper surface has the volutions slightly concave, and traversed transversely by obscure varices, proceeding from the tubercles; the lower side is but little more concave than the other; the volutions are flattened. The entire surface of the shell has delicate transverse and encircling lines, forming a regularly reticulated surface; the aperture is subquadrate.

A beautiful and remarkably discoidal species.

*Geological Position and Locality.* The Great Oolite of Hampton Cliffs; in the collection of W. Walton, Esq.

PLEUROTOMARIA BATHONICA, *Lyc.* Tab. XLV, fig. 10.

*Testa trochiformi, conoidea, spira apice obtuso, anfractibus convexis lineis transversis et perpendicularibus, sub-æqualibus, cancellatis; ultimo anfractu superne tuberculato-nodosis; sinu magno, fascia sinus, plana, transversim lineata, in baso anfractuum sita; ultimo anfractu basi plano, concentrice lineato; umbilico subnullo, apertura subquadrata.*

Shell trochiform, conoidal; spire obtuse; volutions convex, with cancellated transverse and perpendicular lines; the last volution with a row upon the upper part of nodose tubercles; the sinus is large, the fascia of the sinus is flattened and transversely lineated; the base is flattened, and concentrically lineated; the aperture is subquadrate; there is no umbilicus.

The encircling lines, of which there are three or four above the fascia of the sinus, are more prominent than the perpendicular lines. The height is one third less than the basal diameter.

*Geological Position and Locality.* The Forest Marble of the Box Tunnel, near Bath; in the collection of W. Walton, Esq.

PLEUROTOMARIA BURTONENSIS, *Lyc.* Tab. XLV, fig. 8.

*Testa trochiformi, conoidea, anfractibus (5—6), superne inflatis, nodoso-unaulatis, inferne subplanis; superficie lineis transversalibus et perpendicularibus, æqualibus, dense cancellatis, anfractu ultimo basi concentrice et radiatim lineatis, subconvexo, umbilico subnullo; sinu magno, in medio anfractuum situ; fascia sinus delicate cancellatis.*

Shell trochiform, conoidal; volutions (5—6), very convex in their upper parts, and nodosely undulated; their lower portions rather flattened; the surface, with encircling and

perpendicular equal lines, forming a delicately cancellated surface; the last volution has the base wide, somewhat convex, with regular concentric and radiating lines, the latter being the less conspicuous; there is scarcely any umbilical depression; the sinus is large, placed in the middle of the volutions; the fascia of the sinus is delicately cancellated; the nodose elevations upon the upper half of each volution are regular, numerous, and not very strongly defined in the greater number of the specimens.

The height is equal to two thirds of the basal diameter. Of the seven specimens examined, the largest has a basal diameter of about an inch.

*Geological Position and Locality.* The Forest Marble of Burton Bradstock; in the collection of W. Walton, Esq.

PLEUROTOMARIA RECONDITA, *Lyc.* Tab. XLV, fig. 7.

*Testa trochiformi, discoidea, anfractibus (4) subplanis, inferne obtuse carinatis; fascia sinus lata, transverse delicate striata, in medio anfractum situ; anfractibus cingillis angustis (3—4) supra et infra sinus instructo, striis obliquis tenuissimis, impressis; carina marginali lævi; basi lato, concavo, umbilicato, delicate concentrice striato.*

Shell trochiform, discoidal; volutions (4) flattened, but rendered concave in the lower portions by a prominent, obtuse, smooth, marginal carina; the fascia of the sinus is mesial, wide, with very delicate transverse striations; above and beneath the sinus are three or four narrow encircling little costæ, which are impressed by delicate oblique striations; the base is wide, concave, with a distinct umbilicus, with fine concentric striations; the outer lip and sinus have not been obtained perfect.

The height is equal to about three fifths of the basal diameter.

A small species, remarkable for the great breadth of the mesial band, and the prominence of the infero-marginal smooth carina.

*Geological Position and Locality.* The Great Oolite of Bussage, near Bisley Common, and of Minchinhampton Common; it is rare.

ACTEONINA LUIDII, p. 27. Tab. XXXI, fig. 16, and Tab. XLI, fig. 18.

A fine series of examples kindly communicated by Mr. Walton, and collected by him in the Forest Marble of Laycock, has enabled the artist to illustrate the more striking varieties of figure. The differences in the elevation of the spire are so considerable that any measurement of the spiral angle is useless; the sides of the volutions are always flattened, with a mesial angle; in short spired examples the space anterior to the angle is nearly concealed, and the space posterior to it is nearly horizontal.

Another remarkable instance of variability in the elevation of the spire in the same



genus is seen in *A. olivæformis*, Tab. XLI, figs. 4, 4 a, which may be compared with that given in Tab. VIII, fig. 14, part 1.

ACTEONINA SUESSEA, *Lyc.* Tab. XLV, fig. 29.

*Testa ovato-elongata, spira elevata, apice acuminata anfractibus (7) angustis, subangulatis, superne concavis anfractu ultimo basi attenuato; apertura obliqua subreniformi, labro interno incrassato.*

Shell ovately elongated; spire elevated; apex pointed; volutions (7) narrow, convex, subangulated, their upper surfaces concave, their upper borders strongly impressed with a slightly tumid band; the last volution attenuated towards the base; the aperture oblique, and somewhat reniform; the inner lip conspicuous and thickened; the lines of growth are very conspicuous upon the spire.

*Geological Position and Localities.* The Forest Marble at Farleigh, Laycock, and Pound Pill; in the collection of W. Walton, Esq.

ACTEONINA FASCIATA, *Lyc.* Tab. XLIV, fig. 15.

*Testa parva, ovato-elongata aut sub-cylindrica, spira magna elevata, anfractibus (7) angustis, superne convexis, inferne planatis, ultimo anfractu, valde elongato, apertura basi elliptico curvato, postice angusto; superficie lineis plicisque perpendicularibus crebris et irregularibus notatis.*

Shell small, ovately elongated or subcylindrical, the two extremities being somewhat pointed; spire large, lengthened, consisting of seven narrow volutions, which have their upper portions inflated and their sides flattened; the last volution is much elongated and sub-cylindrical; the aperture has its anterior extremity curved elliptically, its posterior position narrow and lengthened; the surface of the shell, with perpendicular, crowded, irregular plications and lines.

The test is delicate, and all the specimens are more or less broken. Length of the largest specimen, 6 lines; breadth,  $2\frac{1}{2}$  lines; length of the aperture, 4 lines.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

ACTEONINA WILTONENSIS, *Lyc.* Tab. XLV, fig. 25.

*Testa parva, sub-fusiformi, ovato-elongata, spira elata, anfractibus (5—6) sub-convexis, anfractu ultimo ovato, apertura elliptica, basi angusto; superficie lineis perpendicularibus, tenuissimis, crebris notatis.*

Shell small, sub-fusiform or ovately elongated, spire elevated, volutions 5 or 6, rather convex; the last volution ovate; aperture elliptical, its base narrow; the surface, with very delicate, closely arranged, perpendicular lines, which render the surface slightly rough.

As the outer lip is much broken in both the specimens examined, the figure of the anterior extremity of the aperture is rather doubtful, and the general figure of the shell is more fusiform than is usual in this genus; the columella is rounded, and quite destitute of any plication.

*Geological Position and Locality.* The Forest Marble of Laycock; in the collection of W. Walton, Esq.

*OSTREA WILTONENSIS, Lyc.* Tab. XXXIV, figs. 1, 1 *a*.

*Testa, valva libera planata, crassa, solida, ovato-triangulari, brevi, apice erecto, obtuso; sulco cardinis lato, superficiali. Valva affixa ignota.*

Shell with the free valve flattened, but solid and thick; its borders are raised internally, rendering the inner surface somewhat concave; the figure is ovately triangular, but short, with the apex erect and obtuse; the hinge sulcus is wide and superficial. The affixed valve is unknown.

Several large specimens of this ponderous but flattened oyster have been obtained by Mr. Walton, including the monstrosity, Tab. XXXIV, fig. 1 *a*. The height is greater than the opposite measurement; it has some resemblance to *O. deltoidea*, but less flattened, not transverse, and with the umbones not oblique; and as the specimens are constant in their general characters, there can be no doubt of its distinctness from that species.

*Geological Position and Locality.*—The Forest Marble of Pound Pill.

*OSTREA (EXOGYRA) LINGULATA, Walton MSS.* Tab. XXXII, figs. 2, 2 *a*, 2 *b*.

*Testa valva inferiore sublævi, excavata, elongata, postice carinata, margine anteriore subrecto, cardine brevi, antrorsum curvato. Valva libera planata, elongata, linguæformi, umboni compresso, arcuato; facie interno sulco longitudinali oblique instructo.*

Shell, with the affixed valve excavated, elongated, smooth, with a posterior external, longitudinal angle; hinge margin short, and curved forwards; anterior border straight, posterior border curved elliptically. Free valve flattened, smooth, lengthened, and tongue-shaped, tapering towards both the extremities; the umbo is depressed, and much curved; the inner surface with a lengthened posterior sulcation. The length is usually about twice the opposite diameter.

A species allied to *Exogyra carinata*. Roemer Nordd, Ool., p. 66, pl. 3, fig. 15. This latter, however, appears to have the affixed valve more flattened and lunulate.

*Geological Positions and Localities.* This oyster appears to be abundant in the Upper Bathonian Clays of Wiltshire. Mr. Walton has collected it in the Forest Marble of Pound Pili, Farleigh, and Hinton, also in the Cornbrash of Hilperton.

*Genus—Harpax*—Parkinson, 1811. Deslongchamps, 1858.

Shell irregular, inequivalve, attached by the umbo of the larger or right valve ; surface radiately ribbed or smooth, usually with concentric, irregular, lamellose plications, imbricated or tuberculated ; borders of the valves close fitting and irregular.

Hinge in the attached valve consisting of a large, flattened, triangular plate, traversed by a central perpendicular or oblique furrow to receive the ligament, with somewhat elevated borders, exterior to which are slightly marked diverging sulcations to receive the elevated borders of the ligamental groove in the other valve ; the outer borders of the plate form lengthened and elevated dental processes.

Hinge in the left or free valve with a triangular plate traversed mesially by the ligamental groove, the borders to which are elevated and but slightly diverging ; exterior to these are strongly impressed grooves to receive the dental processes of the other valve ; the dental processes forming the diverging borders of the plate are but little produced.

The hinge plate in each valve has transverse striations of growth.

The adductor scar is round, placed posterior to the middle of the valve, and strongly marked ; the pallial sinus is simple.

The genus *Harpax* having originally been imperfectly described by Parkinson, and founded upon a single small species, remained but little noticed and accepted by few authors until the year 1858, when it was re-established and amply illustrated in a copious work\* on the 'Fossil Plicatulas and allied Genera,' by that eminent and veteran palæontologist M. Eudes, E. Deslongchamps, who to the long list of memoirs in which he has so ably developed and illustrated the Jurassic fossils of Normandy, has added the present, which probably surpasses all the former in the critical acumen and lengthened researches which it has necessitated. Of the fifteen species of *Harpax* known to M. Deslongchamps all are Liassic, with one exception (*H. scapha*), from the ferruginous (Inferior?) Oolite of Longwy ; the following fine species is therefore the first example of the genus in the oolites of this country.

\* Essai sur les Plicatules fossiles et quelque autre genres voisins ou démembrés de ces coquilles, par M. J. A. Eudes Deslongchamps. Extract du XIe volume des 'Memoires de la Société Linnéenne de Normandie,' Caen, 1858.



HARPAX WALTONI, *Lyc.* Tab. XXXII, figs. 1, 1 *a*, 1 *b*.

*Testa (valva dextra) magna, crassa, ovata, convexa, sub-auriculata, late adherente, radiatim costatis, lamellis incrementi crebris, crassis nodiferis et imbricatis, facie interno, tabula cardinali magno dentibus et foveis longissimis insigni. Valva sinistra depressa, crassa, lamellis ut in valva altera, tabula cardinali dentibus prominentibus, longissimis, obliquis, sulcis conformibus.*

Shell of large dimensions, the right valve with a very large surface of attachment, sub-auriculated, thick, ovate, convex, the surface radiately costated, with thickened, crowded, imbricated and elevated lamellæ of growth; the triangular hinge plate is very large, oblique, transversely striated; the diverging outer grooves which receive the dental processes of the other valve are large, deeply impressed, and exhibit in their course three deeper portions or pits adapted to the successive positions occupied by the anterior projecting or bossed extremities of the dental processes in the free valve; the adductor scar is very large and posterior.

The left or free valve is thick, but less convex than the other; the hinge area occupies upwards of two fifths of the length of the valve; the ligamental groove is narrow and deeply marked, but the other furrows are superficial; the outer diverging dental processes are lengthened and conspicuous, terminating anteriorly in projecting bosses; the adductor scar is prominent and sub-central. In the specimen figured with the valves in contact, the right valve has adhered to a smaller specimen of the same species, whose exposed inner surface exhibits the usual characters of the *left* valve.

Our species is allied to *Harpax calvus* and *H. senescens*, Desl., from the Middle Lias of Calvados, but has more prominent rugose lamellæ, and a larger hinge area in both the valves. In the left valve the anterior termination of the dental processes in bosses with corresponding pits in the furrows of the other valve, has no counterpart in the figures or descriptions of M. Deslongchamps, but as they do not appear to be equally persistent in all specimens their importance can only be small.

*Geological Positions and Localities.* The Forest Marble of Farleigh Wick, Somerset; collected by W. Walton, Esq., whose labours have been rewarded by the acquisition of several good specimens. The interiors of the valves of this species have also been observed in the Great Oolite of Minchinhampton; in these instances, however, their external surfaces could not be disengaged.

GERVILLIA WALTONI, *Lyc.* Tab. XXXII, figs. 4, 4 *a*, *b*.

*Testa fragili, ovato-oblonga, valva sinistra antice convexa, postice explanata in alam brevem producta, umboni prominente, apice acuto, subterminali, ala antica brevi, margine*

*cardinali obliquo, area cardinis longitudinaliter striatis, sulcis transversis magnis (4), dentibus obliquis internis paucis inconspicuis; superficie plicis incrementi delicate instructis. Valva altera mediocri convexa.*

Shell fragile, ovately oblong; left valve anteriorly very convex, moderately thick, and steep; posterior side expanded, attenuated, and produced into a short wing; umbo prominent, acute, subterminal, the anterior wing being short; the hinge margin is oblique, of moderate length; the hinge area has two or three prominent longitudinal striations; the cardinal transverse sulci, four in number, are large and irregular; the internal oblique teeth are few and inconspicuous; the surface with numerous delicate plications of growth. The other valve is of nearly equal convexity and more strongly plicated.

A well marked convex species, with the hinge border moderately oblique, and the whole of the posterior side expanded and delicate.

*Geological Position and Locality.* The Forest Marble of Farleigh and Pound Pill; in the collection of W. Walton, Esq.

GERVILLIA ORNATA, *Lyc.* Tab. XXXVI, fig. 7.

*Testa parva, ovato obliqua; valva sinistra convexa, umboni prominente, ala antica producta; postica obliqua, brevissima; superficie striis tenuissimis concentricis, regularibus, lineisque radiantibus decussatis. Valva altera ignota.*

Shell small, ovately oblique; the left valve inflated, the umbo prominent and situated nearly in the middle of the hinge line, which slopes from it obliquely in upon each side; the anterior wing is produced and rounded, the posterior wing is very short; the surface of the valve has very delicate, regular, concentric striations, which are decussated by elevated lines which diverge from the umbo. The other valve is unknown.

A short, oblique, and very convex Gervillia; the radiating lines upon the middle of the valve are slightly undulating and conspicuous, but gradually disappear towards the sides. The general figure is allied to *G. ovata*, Sow., but the latter is less convex, and its surface is destitute of ornamentation.

Length, 5 lines; breadth, 3 lines. From the position of the shell in our figure the short posterior wing is not seen, and the convexity is scarcely sufficiently conspicuous.

*Geological Position and Locality.* The Great Oolite of Bussage, adjoining Bisley Common; collected by E. Witchell, Esq.

GERVILLIA BICOSTATA, *Lyc.* Tab. XL, fig. 21.

*Testa per-obliqua, convexa, ala antica brevi, altera longiora, emarginata, dorso, costis obliquis elevatis (2) distantibus, plicis incrementi magnis decussatis. Valva dextra ignota.*

Shell small, very oblique, convex; the anterior wing short, thick, and gibbose; posterior wing more lengthened, emarginated posteriorly; the middle of the valve with two elevated, oblique, longitudinal, distantly arranged costæ, which are crossed by large irregular folds of growth; the right valve has not been obtained.

Our sole specimen has the posterior extremity imperfect.

*Geological Position and Locality.* The Great Oolite of Bussage, near Bisley Common; collected by E. Witchell, Esq.

PERNA MYTILOIDES, *Lam.* Tab. XXXII, fig. 3.

PERNA MYTILOIDES, *Lamark.* An. sans Vert., 6 Bd., p. 142.

—	—	<i>Zieten.</i>	Pet., p. 71, pl. 54, fig. 2.
—	—	<i>Goldf.</i>	Pet., p. 104, t. 107, fig. 12.
—	—	<i>D'Orb.</i>	Prodrome de Paléont., 1, p. 311, No. 211.
—	—	<i>Morris.</i>	Catal., 1854, p. 179.
—	—	<i>Oppel.</i>	Jura formation, p. 607, No. 79.
—	—	<i>Quenstedt.</i>	Der Jura, p. 383, tab. 52, fig. 8.
—	—	<i>Damon.</i>	Geol. Weymouth, Suppl., pl. 2, fig. 5.

*Testa ovata-sigmoidea, convexo-plana in alam brevem producta, umbonibus acutis prominentibus, margine cardinali obliquo, foveolis (8-12) plano-concavis.*

Shell thick, ovately sigmoidal, with a moderate convexity, slightly produced posteriorly into a short imperfect wing; the hinge margin is wide, oblique with transverse pits from eight to twelve in number, and only slightly impressed; the anterior border of the valves is much thickened and excavated.

*Geological Positions and Localities.* The Forest Marble of Farleigh; in the cabinet of W. Walton, Esq. Unfortunately none of the Forest Marble specimens are altogether perfect. The Geological range of this Perna must be very considerable, if there is no mistake in the identification of the species. Professor Quenstedt records it in the Inferior Oolite of Wurtemberg; Goldfuss, in the Oxford Clay and Upper Oolite of Baireuth and Wurtemberg; D'Orbigny quotes it from Villiers, Trouville, Lyon, Chaumont, Pizieux, Marolles (Sarthe), and other localities in the same department, all in his 'Etage Callovien.'

Mr. Damon has figured it from the Oxford Clay of Weymouth; and it has been recorded in the Kimmeridge Clay of the latter place; and the Portland Oolite of Swindon, by Professor Morris.

PERNA OBLIQUA, *Walton MSS.* Tab. XXXIV, fig. 22 a.

*Testa subæquivalvi convexo-plana, crassa, umbonibus acutis, prominentibus, margine anteriore recto, margine cardinali recto, oblique declivi, valvis lamellis irregularibus*



*concentricis instructis. Area cardinis angusta, elongata, foveolis (8) latis, subconcavis.*

Shell subequilateral, moderately convex, slightly arched longitudinally in the left valve; test thick, umbones acute and prominent; anterior border straight; hinge-border moderately lengthened, straight, sloping obliquely downwards. Hinge-area narrow, elongated, pits (8) wide, and only slightly concave; lamellæ of growth large and irregular.

Length, about twice as great as the transverse measurement; diameter through the valves, one third of the length.

*Geological Position and Locality.* The Forest Marble of Gastard; in the cabinet of W. Walton, Esq.

PECTEN SUBSPINOSUS, *Schloth.* Tab. XL, fig. 14.

PECTEN SUBSPINOSUS, *Schloth.* Petref., p 223.

— — *Goldfuss.* Petref., t. 90, fig. 4.

— — *Quenst.* Der Jura, p. 500, pl. 67, figs. 3, 4; and pl. 92, figs. 5, 6.

*Testa ovato-orbiculari fornicata æquivalvi, costis (12) æqualibus elatis subacutis in dorso spinosis, sulcis conformibus transversim lineatis, auriculis inæqualibus costatis lineisque decussantibus striatis.* (Goldfuss.)

Shell ovately orbicular, equivalve; costæ (12) large, elevated, subacute, each having upon its ridge a few short spines; the interstitial sulcations are narrow, with delicate, transverse lines; the auricles are unequal, the anterior auricle of the right valve being the larger; they have radiating and decussating lines. The valves have but little convexity; the radiating costæ form one third of a circle.

Height, 7 lines; transverse diameter, 9 lines.

*Geological Positions and Localities.* The Forest Marble of Locus and Farleigh, Somerset; in the collection of W. Walton, Esq. The foreign localities cited by Professor Quenstedt are Bopfingen and Waldenburg, in the Parkinsoni Oolite and the Bradford Clay; also Nattheim, in the Coralline Oolite.

MACRODON HIRSONENSIS, var. RUGOSA. Tab. XXXVI, fig. 9.

The Forest Marble of Wilts and Somerset has this species in the form of a variety which is distinguished from the shell of the Inferior and Great Oolite by the following features:—It has greater convexity, a wider hinge-area; the posterior side is more depressed, and is not uncommonly traversed by two or three radiating furrows, and is in some instances separated from the other portion of the surface by a distinct keel. The

folds of growth upon the sides of the valves are also remarkably, conspicuous, rendering the surface rugose, and the basal sinuation is very strongly defined; in some of the more aberrant forms the posterior side is so much shortened that the umbones are nearly mesial; they are then much elevated, and an oblique keel descends to the infero-posterior extremity. Our illustration faithfully represents this variety, numerous specimens of which have been placed at our disposal by the kindness of Mr. Walton.

CARDIUM GLOBOSUM, *Bean*. Tab. XXXVIII, figs. 2, 2 *a*, 2 *b*.

CARDIUM GLOBOSUM, *Bean*, in *Mag. of Nat. Hist.*, 1839, p. 60, fig. 18.

*Testa suborbiculari, æquilatera, convexa, marginibus ellipticis curvatis; superficie striis concentricis, tenuissimis, crebris instructis.*

Shell suborbicular, equilateral, convex; the umbones moderately produced, acuminate, and incurved; the margins of the valves are elliptically curved; the surface has very delicate, regular, closely arranged, concentric striations.

The length and breadth are equal; the diameter through the valves is two fifths less. Our illustration is taken from the original specimen figured by Mr. Bean; its outline should be somewhat more orbicular. The striated surface readily distinguishes it from *Cardium cognatum*, *Phil.*, which in other respects it resembles.

*Geological Position and Locality.* The Cornbrash of Scarborough; in the collection of Mr. Leckenby.

LITHODOMUS PORTERI, *Lyc.* Tab. XL, fig. 29.

*Testa parva ovato-oblonga, convexa, angusta, umbonibus obliquis, subterminalibus; margine anteriore recto, posteriore elliptico curvato, costis longitudinalibus numerosis, tenuibus lineis concentricis decussatis.*

Shell small, ovately oblong, narrow, convex; umbones oblique, subterminal; anterior border straight, its sides steep; posterior margin curved elliptically; longitudinal costæ numerous, delicate, closely arranged, sometimes bifurcating towards the lower border, and decussated by closely arranged, concentric lines.

The ornamentation is most prominent towards the middle of the valves, and is very faintly traced upon the anterior side. It is allied to *Lithodomus parasiticus*, *Desl.*, *Mor.*, and *Lyc.* ('Gr. Ool. Mon.,' "Biv.," p. 41, Tab. IV, fig. 19), but has greater convexity, and is more narrow and cylindrical; the numerous costæ and decussating lines are also distinctive features.

*Geological Position and Locality.* Collected by W. Walton, Esq., in the Great Oolite of Hampton Cliffs, near Bath.

Dedicated to Henry Porter, Esq., M.D., who has investigated the geology in the neighbourhood of Peterborough.

## NOTES AND CORRECTIONS.

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*Fossils figured in the former parts of this Monograph from the Coast of Yorkshire, and attributed to the Great Oolite.*

It may now be stated, as the general conviction of Palæontologists who have critically studied the subject, that the Testacea of all the marine beds intercalated with the important but local plant-bearing shales and sandstones of the Yorkshire coast, intermediate the Cornbrash and the Dogger, constitute an Inferior Oolite fauna, but that the mineral character of these deposits and their sequence are peculiar to the locality; it is found also, as might be expected in deposits so isolated in their general conditions, that the fauna of these several marine beds, although undoubtedly pertaining to the Inferior Oolite, cannot be arranged with precision upon any corresponding horizons of the same formation, either in Britain or upon the Continent. But in discarding the correlative value of the minor subdivisions, it appears that they may be assigned approximately to those groups of beds which constitute the upper portion of the Inferior Oolite, and which have been divided by Quenstedt, Oppel, and others, into two distinct stages, the lower of which is characterised by the presence of *Ammonites Humphriesianus*, the upper by *Ammonites Parkinsoni*. Upon the coast of Yorkshire these Ammonites, however, have occurred in the same bed, and the number of marine floors is so few that they cannot be considered as representing the two superior stages in the entity of their mass and of their fauna; their deficiencies are more especially remarkable in the rarity of the Brachiopoda and of the Ammonites.

These conclusions have been arrived at by an investigation of a series of details so extensive and decisive in their results as to admit of no uncertainty upon the subject. That the marine beds in question should have been assigned to the Great Oolite upwards of thirty years since by the author of the 'Geology of Yorkshire' will not excite surprise in any one who is able to recall to memory the rudimentary condition of Palæontology at that period, and the absolute ignorance which then prevailed of the Testacea of the Great Oolite; that the Palæontology of the Jurassic portion of the work in question constituted a great advance upon the previous work of Messrs. Young and Bird was at once recognised, and the author candidly stated that he assigned these marine intercalated beds to the Great Oolite solely from their position—higher than certain beds of undoubted Inferior Oolite, and lower than the Cornbrash. The progress of knowledge tending to arrange them with the Inferior Oolite, was gradual. Following the work of Professor Phillips, in 1839 appeared the two well-known memoirs of Professor Williamson on the distribution of organic remains in the Oolitic rocks of Yorkshire, in which the subordinate beds of the Lower Oolites and their organic



contents are detailed with all the care and precision that might be expected from a person who had been long resident in the locality. Within the few years following appeared the elaborate works of Goldfuss, Ziethen, Roemer, Dunker, Agassiz, Deshayes, Sir R. Murchison's second edition of the 'Geology of Cheltenham,' the 'Catalogue' of Professor Morris, the memoir of D'Archiac on the Aisne, several memoirs by M. Eudes Deslongchamps on the fossils of the Oolites of Normandy, a portion of the 'Paléontologie Française' of D'Orbigny, Quenstedt's 'Wurtemberg,' and the 'Lethea' of Bronn. These works, together with others which bear less directly upon the subject of the Lower Oolites, tended very materially to extend and correct the knowledge of their fossils. During the same period also the fossils of the Great Oolite in Gloucestershire had become extensively dispersed, and were compared with those from the Yorkshire coast, collected and distributed with great perseverance by Mr. Bean during a lengthened period. The first published results of influences so potential appeared in 1850, when M. d'Orbigny, in his 'Prodrome de Paléontologie,' placed many of the so-called Great Oolite Yorkshire fossils in his Étage Bajocien, or Inferior Oolite. In the same year appeared the first part of the monograph on the Great Oolite Mollusca, in the introductory remarks to which the authors pointed out the affinity of the Yorkshire so-called Great Oolite fauna to that of the Inferior Oolite, and, as a measure of precaution, were careful to keep the doubtful Yorkshire fossils distinct, both in plates and descriptions, from the Great Oolite fossils of the south of England. The various works and lesser memoirs upon the Lower Jurassic rocks published between 1850 and the present time would of themselves constitute a considerable list. Without enumerating them, it will be sufficient to mention that, in 1856-8, Dr. Albert Oppel, in his remarkable work, 'Juraformation,' placed the Yorkshire Phytiferous beds with the Inferior Oolite, and considered that they did not even represent the highest stage of that formation. In 1857 the present writer expressed, in a little work, 'The Cotteswold Hills,' convictions of similar import. In 1859 Dr. Wright enforced similar views, accompanied by extensive details and lists of Inferior Oolite fossils, in a contribution to the 'Journal of the Geological Society.' The previous Great Oolite Monograph contains four plates of these Yorkshire intercalated marine Testacea; some of which, however, pass upwards into the Great Oolite of the Cotteswolds and into the Cornbrash, as will be ascertained from the descriptions. In excluding them from the present Supplementary Monograph, the writer begs to state that he consented to their admission into the former work with great reluctance, in deference to the opinion then prevalent that they pertained to the Great Oolite, but with a strong impression (formed in 1839, upon perusing the memoir of Professor Williamson) that they constituted an Inferior Oolite fauna.

The Palæontologists of France, in their expositions of the Great Oolite fossils of that country, have, within the last few years, fully proved, by the general identity and association of species, that the fauna of the Minchinhampton beds is not exceptional or local merely, as some have supposed, but represents a very ample and characteristic series of Mollusca, a large number of which are also found in other and distant localities at the same geological horizon. Other not less interesting and important facts, confirmatory of this view, have recently been afforded by researches in English strata of the same epoch. The Oxfordshire railway sections of the Great Oolite and Forest Marble have yielded to Mr. Whiteaves a varied series of Testacea, a list of which he has kindly communicated to me, together with many of the fossils, including those which are not known in the Minchinhampton beds; the result is, that of 122 Great Oolite and 48 Forest Marble shells, in all 140 species, obtained by that gentleman in the Oxfordshire beds, upwards of 114 are also common to the Minchinhampton beds. An extensive series of Forest Marble shells from the clay beds of Wiltshire, Somersetshire, and Dorsetshire, liberally placed at my disposal by Mr. Walton, has produced a larger number of novel forms, as might have been expected from the very different lithological conditions of the deposit; nevertheless there is still a majority of Minchinhampton shells, and the entire assemblage is even more remotely allied to the Yorkshire fauna than is that of Minchinhampton. The general discordance, therefore, of the Yorkshire and southern faunas of the supposed Great Oolite within so small an area as England would lead us to infer their separation chronologically, even if we were unable to assign the northern series to that of an older and well-known era.

The following is a list of Yorkshire Testacea figured in the former Monograph which are not known to occur in any stratum more recent than the gray limestone of Scarborough, and should therefore, in accordance with the foregoing views, be excluded from the fauna of the Great Oolite:

## PART I.

- AMMONITES BRAIKENRIDGII. Tab. XIV, fig. 1.  
 — BLAGDENI. Tab. XIV, figs. 3 *a*, *b*.  
 BELEMNITES GIGANTEUS. Tab. XIV, figs. 4, 4 *a*.  
 SERPULA PLICATILIS. Tab. XIV, figs. 5, 5 *a*, *b*.  
 — SULCATA. Tab. XIV, fig. 6.  
 CERITHIUM BEANII. Tab. XV, fig. 5.  
 CHEMNITZIA (?) VETUSTA. Tab. XV, fig. 7.  
 — SCARBURGENSIS. Tab. XV, fig. 8.  
 ACTEON SEDGVICI. Tab. XV, figs. 9, 9 *a*.  
 — PULLUS. Tab. XV, fig. 11.  
 ACTEONINA GLABRA. Tab. XV, fig. 10.  
 — TUMIDULA. Tab. XV, fig. 14.  
 PHASIAVELLA LATIUSCULA. Tab. XV, fig. 16.  
 NATICA ADDUCTA. Tab. XV, figs. 17, 17 *a*.  
 — (EUSPIRA) CINCTA. Tab. XV, fig. 20.  
 TROCHUS LECKENBYI. Tab. XV, figs. 21, 21 *a*.

## PART II.

- MYTILUS (MODIOLA) LECKENBYI. Tab. XIV, fig. 9.  
 CUCULLÆA CANCELLATA. Tab. XIV, fig. 12.  
 UNICARDIUM GIBBOSUM. Tab. XIV, fig. 11.  
 TRIGONIA SIGNATA—DECORATA. Tab. XV, fig. 1.  
 ASTARTE ELEGANS, *Phil.* (non *Sow.*). Tab. XIV, fig. 14.  
 ISOCARDIA CORDATA. Tab. XV, fig. 5.  
 MYACITES BEANII. Tab. XV, figs. 11 *a*, *b*.  
 — SCARBURGENSIS. Tab. XV, fig. 13.  
 — ÆQUATUS. Tab. XII, fig. 15.

*Cornbrash of the Coast of Yorkshire: its Mollusca.*

The Mollusca of the Yorkshire Cornbrash offer, in their association, some marked contrasts with those of the southern counties and of the Continent upon the same geological horizon. In the southern localities the marine floors, crowded almost exclusively with Brachiopoda, is the predominating feature that arrests the attention; in the northern the Conchifera constitute the great majority; the Brachiopoda, few individually, are reduced almost to the two species *Terebratula lagenalis* and *T. obovata*, the latter being represented by forms dwarfed to about a third of the linear dimensions which the species attains in Wiltshire. The condition of the Testacea also offers some interesting contrasts. In Wiltshire the Conchifera are usually in the condition of casts, of which a large proportion are compressed and distorted; in Yorkshire the hard, dark-coloured limestone has preserved the more delicate external characters in a very



perfect manner, including the thin tests of *Pholadomya*, *Myacites*, *Gresslya*, *Goniomya*, and *Cercomya*, together with the outer, granulated tegument of the four latter genera; and when the matrix is less hard, even their internal hinge characters may be disclosed. The Gasteropoda are few, both as to species and individuals; the Cephalopoda are, with the exception of a small Belemnite, limited to *Ammonites macrocephalus*, which affords great variety in the details of its figure and ornamentation, but which never attains to the large dimensions of Wiltshire specimens.

Its Mollusca, viewed comprehensively, may be regarded as a transitive series, a chain of life serving to connect the fauna of the Inferior Oolite with that of the Oxfordian rocks, comprising a considerable proportion of the former, perhaps an equal number of special forms, a much smaller number of species which pass upwards into the Oxfordian beds, and a still lessening proportion of forms which are recognised in the Great Oolite or Forest Marble, but these latter consist almost entirely of shells which pass upwards from the Inferior Oolite.

### *Minute Testacea of the Great Oolite and Forest Marble.*

Only a portion of these have been selected for illustration, others, inconveniently minute, having been rejected upon that account. That some of these minute forms attain to much larger dimensions under different conditions may be inferred from the fact that many minute Gasteropoda and Conchifera associated with them are only dwarfed forms of well-known Great Oolite species, which in other beds are of the dimensions figured in the former parts of this Monograph.

### *Forest Marble Testacea.*

The following note, kindly communicated by Mr. Walton, describes the localities of the Forest Marble cited in this Monograph:

"The principal localities from which these fossils have been obtained are Farleigh, Hungerford, in Somersetshire; Pound Pill, near Corsham, and Laycock, in Wiltshire; and Burton Bradstock, about five miles from Bridport. The lithological character of the Forest Marble is very various, demonstrating the littoral character of the deposit, which is shown also by the trails of animals and the numerous remains of what can hardly be anything but Fucoids. The best locality at Farleigh is a superficial cutting opposite Wick Farmhouse, made in forming the new Warminster Road, and the bed is a crumbly, shelly marl, and the fossils, when first found, apparently mere lumps of clay. In the small quarries near Hinton Charterhouse, Cumberwell, and Philips Norton, the rock is a hard, calcareo-arenaceous stone, and at Pound Pill it is as hard and more intractable than Carboniferous limestone. At the railroad-cutting near Laycock it is a cream-coloured clay, containing shells better preserved than usual, and from this nearly all the small shells have been procured. In many places the Forest Marble is a mere mass of broken shells, and frequently formed almost exclusively of crushed *Rhynchonellæ*. At Burton Bradstock the Forest Marble clay rests on the lower beds of the Inferior Oolite, and most of the fossils from that locality were picked up from a bank on the sea-shore. I have never found an Ammonite in the Forest Marble, and only one very doubtful trace in the Cornbrash."

*Testacea from the Clays of the Forest Marble compared with those from the Limestones of the Great Oolite.*—As might be anticipated from the widely differing mineral conditions of the two deposits, they are tenanted to a great extent by different races of Molluscs. The fossils figured in this Supplement from the Forest Marble by no means represent the whole of the additional species contained in the clay beds of that stage, but such only as from their state of preservation are suitable for our plates; a large proportion have



suffered from vertical compression and consequent distortion, so that in many instances it has only been possible, even with the choice of numerous specimens, to select one or two as representatives of their respective species, and some tablets covered with shells have with reluctance been rejected when specific forms could only have been made up by the aid of doubtful restorations. Our note on the age of the gray limestone of the Yorkshire coast alludes to the general identity of species which obtains between the Testacea of the Great Oolite and Forest Marble *limestones* of Gloucestershire and of Oxfordshire; they form, in fact, but one fauna, the most prominent species of which are abundant only over very limited areas. In the Forest Marble *clays* we find that the great mass of the organic forms belong to but few genera; the deficiencies in this respect are very striking. The large collection of Mr. Walton contains not a single Ammonite or Belemnite; of Gasteropoda there is almost an entire absence of Nerinæa, Cylandrites, Ceritella, and Trocholoma, genera so abundant and varied in the limestones; these deficiencies are to a great extent compensated for by an abundance of special forms of Phasianella and of Acteonina, which is the more remarkable as the latter genus is everywhere one of the most rare forms of the limestones. The genus Cerithium is abundant, consisting of forms less dwarfed than is usually seen in the limestones. The genera Nerita, Trochus, and Monodonta, are well represented, but the two latter genera for the most part by forms special to the clays. Of the Conchifera the clays produce Tancredia comparatively in small numbers and apparently of few species, but their condition is usually such as will not admit of a rigid scrutiny; a similar paucity applies to the Arcas, Trigonias, Limas, and Pectens. Perna, Gervillia, Pteroperna, and Astarte, are for the most part represented by species special to the clays or rare in the limestones; Pholadomya, Homomya, Myacites, and Goniomya, appear to constitute the rarest generic forms in the deposit; Cercomya and Thracia, perhaps, are absent altogether. Wanting these, the clay banks swarmed with a profusion of Nuculæ and Cyprinæ, usually of forms differing from those of the limestones. Perhaps about 25 per cent. would be a fair estimate of the testaceous species special to the clays; but taking only the more common forms of each deposit, the differences between them are much more marked and important than would be inferred from such a proportion of species.

The following, probably, have not been obtained in any other deposit than the Forest Marble :

Turbo Burtonensis.	Pleurotomaria Bathonica.
subtexata.	Ostrea Wiltonensis.
nodifera.	Gervillia Waltoni.
Trochus Burtonensis.	Perna obliqua.
Monodonta comma.	Trigonia arata.
Waltoni.	Lucina Burtonensis.
arata.	Corbis rotunda.
tegulata.	Corbula Hulliana.
Onusbus Burtonensis.	Islipensis.
Natica arata.	Agatha.
texata.	Corbicella subangulata.
alta.	Cyprina bella.
Acteonina Luidii.	Davidsoni.
Suessea.	Astarte robusta.
fasciata.	rustica.
Wiltonensis.	fimbriata.
Phasianella variata.	ignota.
Solarium turbiniformis.	Hilpertonsensis.
Waltoni.	

*Alaria parvula*, p. 22. Tab. III, fig. 12; and *A. cirrus*, p. 22. Tab. III, fig. 13.

Further observations lead to the conclusion that the former shell is the young condition of the latter,

and that the differences in the last volution are owing only to the stage of growth to which the specimens have respectively attained.

Index to Tab. XII, Part II, *add* figs. 13, 13 *a*, Hinge of Corbicella.

Page 95, fifth line from the bottom, *add*, and Tab. XII, figs. 13, 13 *a*.

Index to Tab. XIII, fig. 16, *for* p. 139, *read* p. 140.

*Myoconcha Actæon*, p. 77, Part II, *for* Tab. III *read* Tab. IV.

Tab. XIII, fig. 18, Part II, *alter* the reference to, *Pholas costellata*, p. 142.

Index to Part II, *add*, *Pholas oolitica*, p. 126. Tab. IX, fig. 21.

*Alaria trifida*, Part I, p. 21, *add* the following to the description:—The first two or three volutions are longitudinally costated, the transverse striations extend even upon the caudal and digital processes.

*Pholodomya oblita*, Part II, p. 142\* ; Tab. XII, fig. 5. It is now ascertained that the specimen figured was erroneously assigned to the Great Oolite ; its true position is in seams of sandy marl near to the base of the Inferior Oolite, in which position it occurs at various localities in the vicinity of Stroud and Nailsworth ; the officers of the Ordnance Geological Survey have also procured it from a similar position in Somersetshire. It sometimes attains very large dimensions, as is exemplified by a remarkable specimen in the Bristol Museum, which has been mistaken, as in other instances, for the aged condition of *Pholadomya fidicula*, Sow. The delicate, radiating lines are scarcely distinguishable upon the aged and inflated examples of *P. oblita*, but are always acute and conspicuous upon *P. fidicula*.

*Trigonia decorata*, Lyc., Part II, p. 133, Tab. XV, fig. 1, *alter* the title to *Trigonia signata*, Ag., a fine species, abundant in the Upper Trigonia Grit of the Inferior Oolite in the Cotteswolds, and more rarely in the gray limestone of the coast of Yorkshire ; it occurs in a similar geological position at various Continental localities. Professor Quenstedt has figured it from Wurtemberg under the name of *Trigonia clavellata*. It has never been found to pass upwards into the Great Oolite.

*Patella paradoxa*, Part I, p. 90, Tab. XII, fig. 2. This rare species is the *Patella lata*, Sow., 'Min. Con.,' t. 484, fig. 1, p. 133. The compressed and imperfect specimen figured in the latter work will account for our having failed at an earlier period to identify it with the very few examples which have been obtained at Minchinhampton.

*Tancredia curtansata*, Part II, p. 93, Tab. XIII, figs. 7, 7 *a*, 7 *b*, *alter* the title to *Tancredia subcurtansata* ; it is much less inflated, the umbones are more elevated and pointed, the posterior side is more produced, and it is destitute of the large longitudinal plications which distinguish the species of the Coral Rag ; the latter is also a much larger shell, only two specimens of which have come to my knowledge, the type specimen in the York Museum, the other in the fine collection of Mr. Leckenby at Scarborough. *Tancredia Lycetti*, Oppel, from the Inferior Oolite of Wurtemberg and of Gloucestershire, is also nearly allied to the Coral Rag shell, and appears to be equally rare.

*Tancredia axiniformis*, p. 93, Tab. XIII, fig. 6, and Tab. XII, fig. 7, *alter* the title to *Tancredia extensa*, Lyc. In this instance the name proposed in my first notice of the Genus *Tancredia*, 'Ann. and Mag. Nat. Hist.,' Dec., 1850, must be retained, as an examination of many Yorkshire specimens of *T. axiniformis* leaves no doubt that it is a distinct species, which occurs in the Inferior Oolite, both in that county and in Gloucestershire ; compared with the Great Oolite *T. extensa*, it is shorter, more flattened, approaching more nearly to the outline of *T. brevis*, but with much less convexity.

Tab. XV, Part II, figs. 2, 2 *a*, *alter* the title to *Ceromya Bajociana*, D'Orb. ; the figure represents the usual size attained by this *Ceromya* in the Inferior Oolite of the Yorkshire coast ; in the Cotteswolds the same formation produces it of far larger dimensions, and justifies the terms in which it is described by D'Orbigny in his 'Prodrome,' p. 274, as follows:—"Magnifique espèce courte, renflée à crochets très-



contournés, ornée de stries concentriques d'accroissement, comme rostrée à la région anale." It is the *Isocardia concentrica* of Phillips, 'Geol. York.,' i, pl. xi, fig. 40, but not of Sowerby. The Yorkshire examples may, therefore, be considered as dwarfed forms of this really magnificent shell, the southern examples of which have the distinguishing features of the species much more strongly marked; the umbones, more especially, are larger and more elevated, the posterior extremity being also more rostrated. It is worthy of remark that this degenerated form is the only one of the genus that has been obtained from the whole of the Jurassic rocks of Yorkshire.

*Anatina undulata* and *Anatina plicatella*, Tab. II, Part II, transpose figs. 6 and 4 upon the tab.; the references to them at p. 118, and also upon the page facing the tab., will then be correct.

*Pholadomya ovulum*, Part II, Tab. XIII, fig. 12, alter the title to *Pholadomya ovalis*, Sow.; also at p. 122.

*Turbo capitaneus*, Goldf., Part I, p. 65, erase the words "Tab. IX, fig. 33," and alter to "Supplement, Tab. XLI, fig. 1." The index to Tab. IX, fig. 33, should be altered to *Amberleya Jurassi*, Supplement, p. 19.

*Stomatia?* *Buvignieri*, Part I, p. 85, alter the generic title to *Nerita*. Another figure is given, Supplement, Tab. XLI, fig. 7.

Part II, Tab. VI, fig. 15, p. 67. I agree with Dr. Oppel ('Juraformation,' p. 487) in the propriety of separating this *Lucina* from *L. Bellona*; its title should, therefore, be *Lucina Lycetti*, as suggested by Dr. Oppel.

*Cerithium Roissii*, Part I, p. 32, alter the generic title to *Fibula*. See p. 10 of this Supplement.

*Myacites crassiusculus*, Part I, p. 112, alter the generic title to *Homomya*. See p. 89 of this Supplement.

*Myacites Vezelayi*, Part I, p. 111, alter the generic title to *Homomya*. See p. 88 of this Supplement.

*Myacites gibbosus*, Part I, p. 138, alter the generic title to *Homomya*. See p. 88 of this Supplement.

*Corbula involuta*, Part I, p. 97, alter the title to *Corbula Buckmani*. See p. 63 of this Supplement. *Corbula Buckmani* will be found refigured, Tab. XXXIV, figs. 6, 6 a.

Part II, p. 123, erase the first reference to *Pholadomya Sæmanni*, Tab. II, fig. 1, which is *P. solitaria*.

Part II, p. 28, Tab. IV, fig. 12. This little shell, erroneously ascribed to the *Modiola pulcherrima* of Roemer, has been rectified by Professor Morris, 'Catal,' p. 210, under the appellation of *M. Lycetti*. Compared with the allied species of the Hiltstone, it is smaller, more inflated, the radiating lines are more narrow or more distantly arranged, the test is very thin, and the specimens are usually imperfect.

*Mytilus (Modiola) tumidus*, Part II, p. 37, Tab. IV, fig. 5. It is stated that the rude figure of a *Modiola*, Young and Bird, 'Geol. York. Coast,' pl. vii, fig. 10, is intended to represent this shell, and that Professor Phillips inserted it in his list of Yorkshire fossils, 'Geol. York.,' i, p. 171, in the following terms:—" *Modiola unguolata*, *Coralline Great and Inferior Oolite*." It is not uncommon in the upper stage of the Inferior Oolite in the Cotteswold Hills.

*Purpuroidea Moreausea*, Part I, p. 27, Tab. IV, figs. 1—4, alter the title to *P. Morrisea*. The publication of the splendid work of M. Buvignier on the Palæontology of the Meuse has shown that we were mistaken in assigning our Minchinhampton species to that figured in a very indifferent manner in the little memoir by M. Buvignier in 1843. The new specific name selected for our shell by the latter author should therefore be adopted.

Part I, Tab. II, figs. 3, 3 a, p. 12. The Ammonite obtained at the base of the Great Oolite, and referred doubtfully to *A. macrocephalus*, is now ascertained to be *A. viator*, D'Orb., 'Pal. Fr. Terr. Jurass.,'



tab. 172, of which numerous specimens are now in the British Museum, obtained from a similar geological position in Somersetshire; in some of these the last volution quite conceals all the others, leaving only a small umbilical orifice; the absence of costæ upon the inner portion of the last volution distinguishes it from *A. macrocephalus*. Dr. Oppel ('Juraformation,' p. 478) proposes for it the new title of *A. Morrisii*, which, in accordance with the above views, must remain as a synonym of *A. viator*.

*Acteonina? parvula*, Part I, p. 104, alter the generic title to *Ceritella*.

Part II, Tab. 5, figs. 18 *a*, 19 *a*. Both these figures represent the young condition of *Trigonia Goldfussii*.

*Trochus pileolus*, Part I, p. 66, Tab. 10, fig. 5. Additional specimens have proved that the smoothness of the surface is accidental; traces of encircling striations are sometimes visible; the shell then becomes identical with *Turbo obtusus*, Sow., of which *Trochus Bixa*, D'Orb., is also a synonym.

*Nerita hemispherica*, Roem., Tab. XI, figs. 14, 16; *Nerita minuta*, Sow., Tab. XI, fig. 19. A comparison of very ample materials, including all the connecting forms, leaves no choice but to regard *N. hemispherica* as the adult shell of *N. minuta*. The preservation of the epidermal pattern of coloration has materially tended to this result; the older shells, as in fig. 14, with their strong, rugose plications, thickened columellar lip, and entire absence of the epidermal coat, appear at first sight sufficiently distinct, but from these we pass to specimens of less advanced growth, as in fig. 16, without plications, but still possessing the callosity upon the inner lip; some in this state, however, retain portions of the external tegument, in which may be traced remains of the two broad bands of white between the three of dark-coloured pigment, the latter consisting of transverse, wrinkled lines. From these to the smallest forms the transition is easy; the latter are most commonly more ovate, but this is by no means an invariable feature, nor are the adult shells very constant in the degree in which the spire is produced. The minute forms, which usually retain the epidermal coat, are smooth and shining; with advance of growth the shell exhibits continual and considerable increase of thickness. The two extremes of aspect are fairly represented in figs. 14 and 19. *Nerita minuta* is so inappropriate a name for the adult shell, that it seems desirable to adopt *Nerita hemispherica*, although the former has priority.

*Fusus? subnodulosus*, Part I, Tab. V, fig. 9, p. 23, alter the generic title to *Brachytrema*.

*Phasianella conica*, Part I, Tab. XI, fig. 30, p. 74; *Phasianella acutiuscula*, Tab. XI, fig. 28, and Tab. IX, fig. 2. An examination of numerous additional specimens has led to the conclusion that these forms should be regarded as only varieties of one species; for although some examples are even more lengthened than the figures of *P. acutiuscula*, others connect the typical specimens of each variety in a very perfect manner.

Genus *Brachytrema*, Part I, p. 24. Further information has shown that the generic description before given should be slightly modified; the outer lip was stated to be thin, which is correct as far as regards the greater number of specimens; but some species, as *B. varicosa* and *B. pygmea*, acquired at certain arrests of growth thickened outer lips or varices, as in Triton; from the latter genus they are distinguished by the shorter trochiform spire and absence of denticulations upon the borders of the aperture.

*Turbo? pygmeus*, Tab. IX, Part I, figs. 29, 29 *a*, alter the title to *Brachytrema pygmea*. The doubt as to the genus expressed in Part I, p. 65, has been justified in an example with the aperture perfect, figured by M. Piette, 'Bull. de la Soc. Géol. de France,' 2 sér., pl. xv, fig. 21, under the name of *Brachytrema brevis*; the base is strongly striated, and the aperture much contracted.

*Alaria lævigata*, p. 17, Tab. III, figs. 3, 3 *a*; Tab. XLI, fig. 13, alter the title to *Alaria Myurus*, Desl., sp. It was stated at p. 17 "that in everything excepting its smooth surface this shell agrees with the *Rostellaria Myurus* of Deslongchamps." A specimen recently obtained exhibits some encircling striations upon the upper portions of the two larger volutions; the sole distinction, therefore, that separated it from

the species of Deslongchamps is thus removed. The specimen figured Tab. XLI, fig. 13, exhibits the first spine, which is monodactyle; a second and much larger spine, also monodactyle; the third and ultimate spine being didactyle.

*Acteonina*?, Part I, Tab. VIII, fig. 12\*, is the young shell of *A. olivæformis*, p. 103.

*Lima Luciencis*, D'Orb., 'Gr. Ool. Mon.,' Part II, p. 28, Tab. III, fig. 4. This shell is a synonym of *Lima rudis*, Sow. The number of costæ vary from eight to eleven; the specimen figured in the 'Mineral Conchology,' tab. 214, has only seven costæ, and the figure is unusually gibbose. Its geological range is considerable; it occurs sparingly in the Great Oolite of the Minchinhampton district and in the Cornbrash of the coast of Yorkshire, but in the Coral Rag of Malton it is moderately abundant.

Sub-genus *Crossostoma*, Part I, p. 72. Of the three Oolitic species assigned to this proposed sub-genus of Delphinula, the only one which exhibits the distinctive characters is *C. Pratii*; the other two forms, *discoideum* and *heliciforme*, were formerly supposed to represent in their apertures the immature condition of that sub-genus. Subsequent observations of numerous specimens has compelled me to abandon that view, and to regard *discoideum* and *heliciforme* as adult shells, or discoidal forms of smooth Monodonta. Other examples of Monodonta allied to the Great Oolite forms, but less depressed, have been figured by Messrs. Hebert and Deslongchamps, in their 'Memoir on the Kelloway Rock Fossils of Montreuil-Bellay,' under the names of *Monodonta ovulata* and *papillata*.

*Cerithium quadricinctum*, Goldf., and *C. limæforme*, Roem. These two forms must be united into one species; individuals with large nodules and with only three distinct rows have been assigned to *C. limæforme*, but, even with these, indications of a fourth row are occasionally to be discovered, and the prominence of the nodules, and their number in each volution, are very variable. *C. quadricinctum* has a considerable geological range, and it occurs also in the Coral Rag of Germany.

*Patella suprajurensis*, Part I, p. 92, Tab. XII, figs. 9, 9a. I can now only regard this form as a variety of *P. Aubentonensis*, in which the lamellæ of growth are strongly marked and the cancellated lines have disappeared. It is also not uncommon to meet with smooth examples of the latter species.

*Pholadomya solitaria*, Part II, p. 124, Tab. XI, fig. 1, et Tab. XII, fig. 2; erroneously printed *P. oblita* upon the reference facing the latter table. *Pholadomya oblita* is Tab. XII, fig. 5, p. 142\*. The variations of figure and of ornamentation, either separately or combined, are so considerable in the cordiform examples of *Pholadomya*, that a large number are indispensable to enable us to legislate upon them with any confidence; probably *P. solitaria* is only a variety of *P. deltoidea*, Sow.

[*Note*.—The Author desires to tender his best thanks to Mr. West for the very careful drawings in the plates that illustrate this Monograph ; and more especially for the fidelity and attention to the more minute details exhibited in the magnified figures of the smaller Gasteropoda, from the Great Oolite and Forest Marble.]



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—	Lycetti ... ..	22	XXXI, figs. 14, 14 a.
—	sparsistriata ... ..	22	XLV, fig. 9.
—	tegulata ... ..	102	XLV, figs. 17, 18.
—	Waltoni ... ..	101	XLV, figs. 31, 31 a, b.
NATICA	alta ... ..	97	XLV, figs. 22, 22 a.
—	arata ... ..	97	XLV, fig. 2.
—	Hulliana ... ..	13	XLI, figs. 2, 2 a.
—	insignis ... ..	97	XLV, fig. 21.
—	texata ... ..	96	XLV, figs. 30, 30 a.
NERINÆA	granulata ... ..	10	XXXI, figs. 12, 12 a.
NERITA	clavatula ... ..	98	XLV, fig. 3.
—	involuta ... ..	20	XXXI, fig. 15.
NERITOPSIS	Archiaci ... ..	21	XXXI, figs. 7, 7 a.
ONUSTUS	Burtonensis ... ..	103	XLV, figs. 7, 7 a, b.
PHASIANELLA	variata ... ..	104	XLV, figs. 28, 28 a, b.
PLEUROTOMARIA	Bathonica ... ..	105	XLV, fig. 10.
—	Burtonensis ... ..	105	XLV, figs. 8, 8 a, b.
—	granulata ... ..	24	XXXI, figs. 8, 8 a.
—	recondita ... ..	106	XLV, fig. 7.
PURPUROIDEA	insignis ... ..	6	XXXI, figs. 2, 2 a.
RISSEA ?	exigua ... ..	9	XLIV, fig. 11.
RISSOINA	Milleri ... ..	18	XLIV, fig. 10.
—	subulata ... ..	98	XLI, fig. 9.
—	tumidula ... ..	98	XLIV, fig. 13.

	PAGE	TABLE
RISSOINA <i>Witchelli</i> ... ..	18	XLIV, fig. 12.
SOLARIUM <i>Bathonicum</i> ... ..	23	XLV, fig. 27.
— <i>Waltoni</i> ... ..	104	XLV, figs. 26, 26 <i>a</i> , <i>b</i> , <i>c</i> .
— <i>turbiniiformis</i> ... ..	104	XLV, figs. 23, 23 <i>a</i> , <i>b</i> .
TROCHUS <i>Burtonensis</i> ... ..	99	XLV, fig. 16.
— <i>Gusei</i> ... ..	21	XLV, fig. 14.
— <i>strigosus</i> ... ..	29	XLV, fig. 12.
TURBO <i>Burtonensis</i> ... ..	100	XLV, fig. 15.
— <i>depauperatus</i> ... ..	99	XLV, fig. 13.
— <i>subtexata</i> ... ..	100	XLI, figs. 15, 15 <i>a</i> .
EULIMA? <i>lævigata</i> .. ..	13	XXXI, fig. 3.

## BIVALVIA.

ANATINA <i>siliqua</i> ... ..	83	XXXV, fig. 15.
ARCA ( <i>cucullæa</i> ) <i>clathrata</i> ... ..	44	XXXIX, figs. 4, 4 <i>a</i> .
— <i>corallina</i> ... ..	43	XXXIX, fig. 3.
ASTARTE <i>Aytonensis</i> ... ..	78	XL, fig. 13.
— <i>Bathonica</i> ... ..	76	XL, figs. 23, 23 <i>a</i> .
— <i>flexicostata</i> ... ..	79	XL, fig. 26.
— <i>fimbriata</i> ... ..	77	XL, figs. 34, 34 <i>a</i> .
— <i>Hilpertონensis</i> ... ..	78	XXXVI, fig. 10.
— <i>ignota</i> ... ..	77	XL, fig. 10.
— <i>Leckenbyi</i> ... ..	74	XLII, fig. 3.
— <i>orbicularis</i> ... ..	73	XL, fig. 33.
— <i>politula</i> ... ..	73	XXXV, fig. 16.
— <i>Pontonis</i> ... ..	75	XL, fig. 31.
— <i>robusta</i> ... ..	74	XXXV, fig. 6, 6 <i>a</i> .
— <i>rustica</i> ... ..	76	XXXV, fig. 5; XL, figs. 8, 8 <i>a</i> .
— <i>ungulata</i> ... ..	72	XXXV, fig. 20.
AVICULA <i>clathrata</i> ... ..	36	XL, figs. 7, 7 <i>a</i> , <i>b</i> .
— <i>subcostata</i> ... ..	36	XL, fig. 24.
CARDIUM <i>cognatum</i> ... ..	54	XXXVI, figs. 3, 3 <i>a</i> , 2 <i>b</i> .
— <i>incertum</i> ... ..	53	XXXV, figs. 14, 14 <i>a</i> .
— <i>globosum</i> ... ..	114	XXXVIII, figs. 2, 2 <i>a</i> , <i>b</i> .
— <i>lingulatum</i> ... ..	53	XXXIII, figs. 2, 2 <i>a</i> ; XXXV, figs. 11; 11 <i>a</i> .
— <i>Witchelli</i> ... ..	55	XL, fig. 36.
CORBIS <i>elliptica</i> ... ..	60	XXXV, fig. 1.
— <i>Neptuni</i> ... ..	59	XXXV, fig. 19.
— <i>rotunda</i> ... ..	60	XL, fig. 17.
CORBULA <i>Agatha</i> ... ..	65	XL, fig. 28.
— <i>attenuata</i> ... ..	62	XXXVII, figs. 6, 6 <i>a</i> .
— <i>Hulliana</i> ... ..	64	XXXVII, fig. 5.
— <i>Islipensis</i> ... ..	63	XXXVII, fig. 7.



	PAGE	TABLE
<i>CORBULA involuta</i> ... ..	63	XXXVII, figs. 4, 4 <i>a</i> .
<i>CORBICELLA subangulata</i> ... ..	70	XL, fig. 9.
— <i>subæquilatera</i> ... ..	69	XXXV, fig. 12.
<i>CYPRICARDIA caudata</i> ... ..	55	XXXVI, figs. 8, 8 <i>a</i> .
<i>CYPRINA bella</i> ... ..	71	XL, figs. 15, 15 <i>a</i> .
— <i>Davidsoni</i> ... ..	71	XXXVI, figs. 6, 6 <i>a</i> .
— <i>Islipensis</i> ... ..	70	XXXV, fig. 13.
<i>GERVILLIA bicostata</i> ... ..	111	XL, fig. 21.
— <i>Islipensis</i> ... ..	37	XXXVI, fig. 7.
— <i>ornata</i> ... ..	111	XL, fig. 29.
— <i>tortuosa</i> (var.) ... ..	37	XL, fig. 25.
— <i>Waltoni</i> ... ..	110	XXXII, figs. 4, 4 <i>a</i> , <i>b</i> .
<i>GRESSLYA peregrina</i> ... ..	79	XXXVI, figs. 2, 2 <i>a</i> , 2 <i>b</i> .
<i>GRYPHÆA minuta</i> ... ..	30	XL, fig. 12.
<i>HARPAX Waltoni</i> ... ..	101	XXXII, figs. 1, 1 <i>a</i> , <i>b</i> .
<i>HINNITES gradus</i> ... ..	35	XXXIII, figs. 10, 10 <i>a</i> .
<i>HOMOMYA gibbosa</i> ... ..	88	XLIII, figs. 2, 2 <i>a</i> ; Part II, XII, fig. 14.
— <i>crassiuscula</i> ... ..	89	XLIII, figs. 5, 5 <i>a</i> .
<i>INOCERAMUS quadratus</i> ... ..	38	XXXVIII, figs. 1, 1 <i>a</i> , 1 <i>b</i> .
<i>ISOCARDIA tenera</i> ... ..	57	XXXVIII, figs. 5, 5 <i>a</i> , <i>b</i> .
— <i>minima</i> ... ..	56	XXXVI, figs. 1, 1 <i>a</i> .
— <i>nitida</i> ... ..	57	XXXVIII, figs. 6, 6 <i>a</i> , 6 <i>b</i> , 6 <i>c</i> .
<i>ISOARCA Scarburgensis</i> ... ..	45	XXXIX, figs. 5, 5 <i>a</i> .
<i>LEDA Anglica</i> ... ..	45	XXXIX, fig. 7.
<i>LIMA Helvetica</i> ... ..	41	XXXIII, figs. 8, 8 <i>a</i> .
— <i>pectiniformis</i> ... ..	39	XXXVI, fig. 1.
— <i>punctatilla</i> ... ..	41	XL, fig. 32.
— <i>rigidula</i> ... ..	42	XXXIII, figs. 7, 7 <i>a</i> .
<i>LITHODOMUS Porteri</i> ... ..	114	XL, fig. 9.
<i>LUCINA Beanii</i> ... ..	59	XXXVIII, fig. 3.
— <i>Burtonensis</i> ? ... ..	59	XL, figs. 20, 20 <i>a</i> , <i>b</i> .
— <i>striatula</i> ... ..	58	XXXVIII, fig. 7.
<i>Macrodon Hirsonensis</i> , var. <i>rugosa</i> ... ..	113	XXXVI, fig. 9.
<i>Modiola gibbosa</i> .. ..	42	XXXIII, figs. 11, 11 <i>a</i> .
<i>Myacites calceiformis</i> ... ..	80	XLII, figs. 1, 1 <i>a</i> .
— <i>modica</i> ... ..	83	XLIII, figs. 1, 1 <i>a</i> .
— <i>recurvum</i> ... ..	81	XXXVI, figs. 4, 4 <i>a</i> .
— <i>sinistra</i> ... ..	82	XXXV, figs. 17, 17 <i>a</i> .
<i>NUCULA Menkei</i> ... ..	44	XXXIX, fig. 2.
<i>OPIS Leckenbyi</i> ... ..	61	XXXVII, figs. 9, 9 <i>a</i> .
— <i>Luciensis</i> ... ..	62	XL, figs. 19, 19 <i>a</i> .
— <i>pulchella</i> ... ..	61	Part II, VI, fig. 3.
<i>OSTREA Wiltonensis</i> ... ..	108	XXXIV, figs. 1, 1 <i>a</i> .
— ( <i>Exogyra</i> ) <i>lingulata</i> ... ..	108	XXXII, figs. 2, 2 <i>a</i> , <i>b</i> .
<i>PECTEN anisopleurus</i> ... ..	32	XXXIII, figs. 5, 5 <i>a</i> .
— <i>articulatus</i> ... ..	34	XXXIII, fig. 12.
— <i>Griesbachi</i> ... ..	37	XXXIII, figs. 6, 6 <i>a</i> .

		PAGE	TABLE
PECTEN inæquicostatus	...	32	XXXIII, figs. 1, 1 <i>a</i> .
— Michelensis	...	34	XXXIII, fig. 3.
— rigidus	...	31	XL, fig. 16.
— Rushdonensis	...	33	XXXIII, figs. 4, 4 <i>a</i> , <i>b</i> , <i>c</i> .
— subspinosus	...	113	XL, fig. 14.
— Wollastonensis	...	33	XXXIII, figs. 2, 2 <i>a</i> , <i>b</i> , <i>c</i> .
PERNA foliacea	...	38	XXXVII, figs. 3, 3 <i>a</i> .
— mytiloides	...	112	XXXII, fig. 3.
— obliqua	...	112	XXXIV, figs. 22, 22 <i>a</i> .
PHOLADOMYA deltoidea	...	86	XLII, figs. 4, 4 <i>a</i> .
— lyrata	...	87	XLIII, figs. 3, 3 <i>a</i> .
— ovulum	...	84	XXXV, figs. 18, 18 <i>a</i> .
— Phillipsi	...	86	XLII, figs. 2, 2 <i>a</i> .
PLACUNOPSIS semistriatus	...	30	XXXIII, figs. 9, 9 <i>a</i> .
SOWERBYA triangularis	...	66	XXXV, figs. 3, 3 <i>a</i> , <i>b</i> .
— Woodwardi	...	67	XL, figs. 27, 27 <i>a</i> , <i>b</i> , <i>c</i> .
TANCREEDIA gibbosa	...	68	XXXV, fig. 7; XXXVI, fig. 11.
— mactræoides	...	68	XXXV, fig. 4.
— similis	...	68	XXXV, fig. 9.
THRACIA amygdaloidea	...	80	XLIII, fig. 4.
TRIGONIA arata	...	52	XL, fig. 2.
— Bathonica	...	52	XL, fig. 3.
— Cassiope	...	49	XXXVII, fig. 10.
— clythia	48, 51	...	XXXVII, fig. 2; XL, figs. 5, 5 <i>a</i> .
— compta	...	50	XL, fig. 1.
— elongata	...	48	XXXIX, figs. 6, 6 <i>a</i> .
— Scarburgensis	...	48	XXXVII, fig. 1.
— tripartita	...	51	XL, fig. 4.
— tuberculosa	...	47	XL, fig. 6.



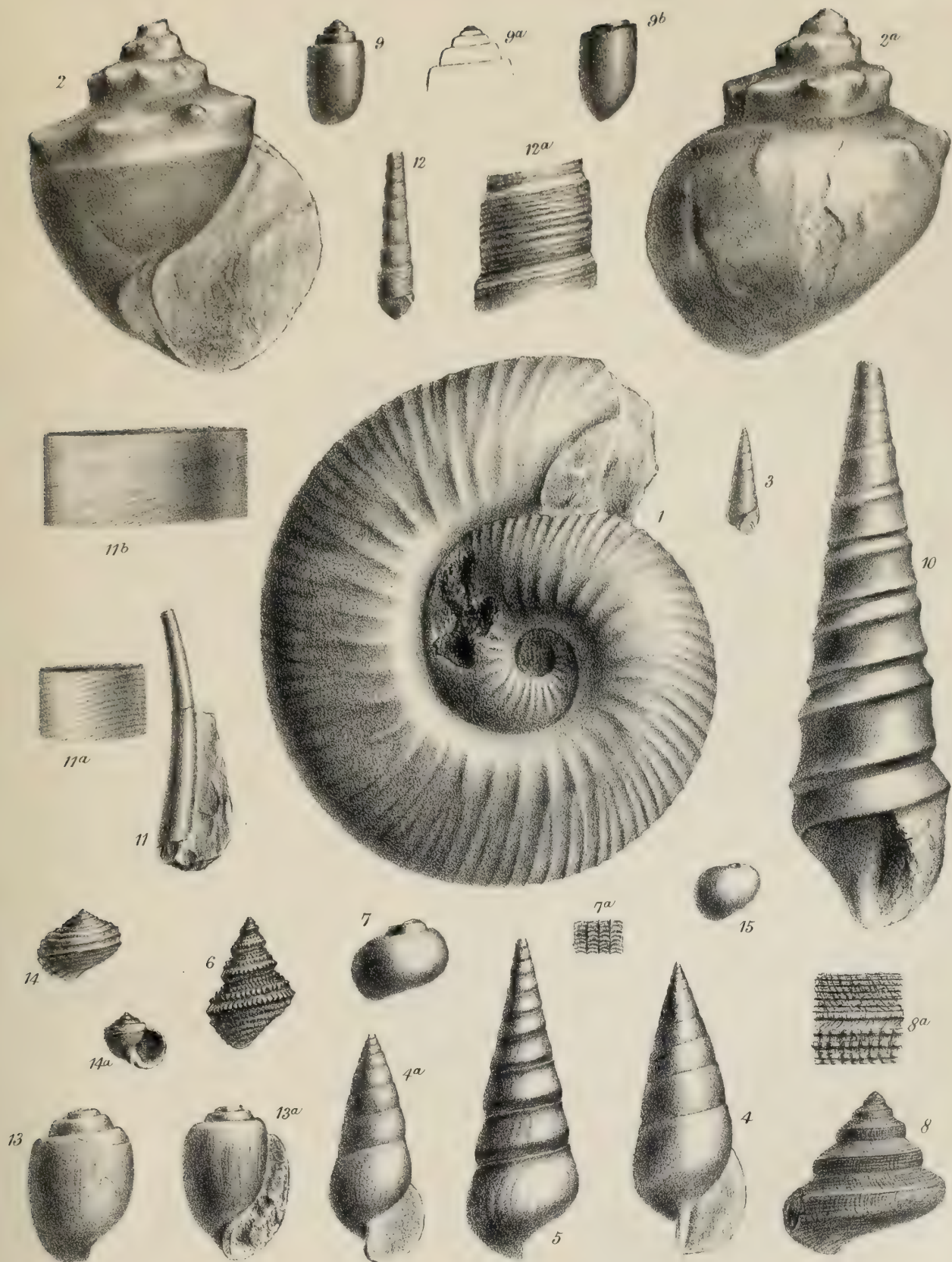




# TAB. XXXI.

FIG.

1. Ammonites Bullatus, *D'Orb.* Reduced one half. Great Oolite (page 3).
- 2, 2 a. Purpuroidea insignis, *Lyc.* An aged shell, in which the tubercles have disappeared upon the anterior portion of the last volution. Great Oolite (page 6).
3. Eulima? lævigata, *Lyc.* Cornbrash (page 13).
4. Fibula variata, *Lyc.* Specimen with the anterior extremity of the aperture approaching to Cerithium.
- 4 a. „ „ With the anterior part of the aperture approaching to Turritella. From the Great Oolite of Kirklington, Oxon. (page 16).
5. „ eulimoides, *Whiteaves.* From the Great Oolite of Stonesfield (page 17).
6. Amberleya armigera, *Lyc.* Cornbrash (page 20).
7. Neritopsis Archiaci, *D'Archiac*, sp. Cornbrash (page 21).
- 7 a. „ „ A portion of the surface magnified (page 21).
8. Pleurotomaria granulata, *Sow.*, sp. Cornbrash (page 24).
- 8 a. „ „ A portion of the surface magnified, including the fascia of the sinus.
9. Acteonina canaliculata, *Lyc.* Great Oolite of Kirklington, Oxon. (page 27).
- 9 a. „ „ The spire enlarged.
10. Chemnitzia vittata, *Phil.*, sp. Cornbrash (page 14).
11. Dentalium entaloides, *Desl.* Cornbrash (page 28).
- 11 a. „ „ A portion of the posterior part of the shell enlarged, to exhibit the oblique striations.
- 11 a. „ „ Enlarged view of the anterior portion of the shell, in which the striations have disappeared.
12. Nerinæa granulata, *Phil.*, sp. Cornbrash (page 10).
12. „ „ A portion of the spire enlarged.
- 13, 13 a. Acteonina Scarburgensis. Cornbrash (page 28).
14. Monodonta Lycetti, *Whiteaves.* Bradfordian beds of Islip, Oxon. (page 22).
15. Nerita involuta, *Lyc.* Great Oolite, Kirklington (page 20).
16. Acteonina Luidii, *Luid.*, sp. Forest Marble, Kidlington, Oxon. A small specimen, with short spire (page 27). See also Tab. LXI, figs. 18 a, b, c.







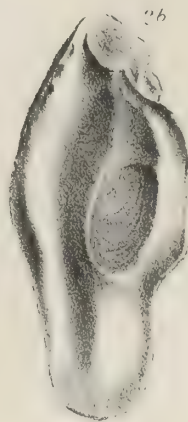
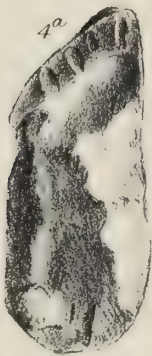


TAB. XXXII.

FIG.

- |                              |  |                               |                           |
|------------------------------|--|-------------------------------|---------------------------|
| 1.                           | Harpax Waltoni, <i>Lyc.</i>                      | The attached valve.           | Forest Marble (page 110). |
| 1 <i>a.</i>                  | „ „  | Interior of the left valve.   |                           |
| 1 <i>b.</i>                  | „ „  | Interior of the right valve.  |                           |
| 2.                           | Ostrea (Exogyra) lingulata, <i>Walton</i> , MSS. | Forest Marble (page 108).     |                           |
| 2 <i>a.</i>                  | „ „ „  | Interior of the convex valve. |                           |
| 2 <i>b.</i>                  | „ „ „  | Interior of the flat valve.   |                           |
| 3.                           | Perna mytiloides, <i>Lam.</i>                    | Forest Marble (page 112).     |                           |
| 4, 4 <i>a.</i> , 4 <i>b.</i> | Gervillia Waltoni, <i>Lyc.</i>                   | Forest Marble (page 110).     |                           |







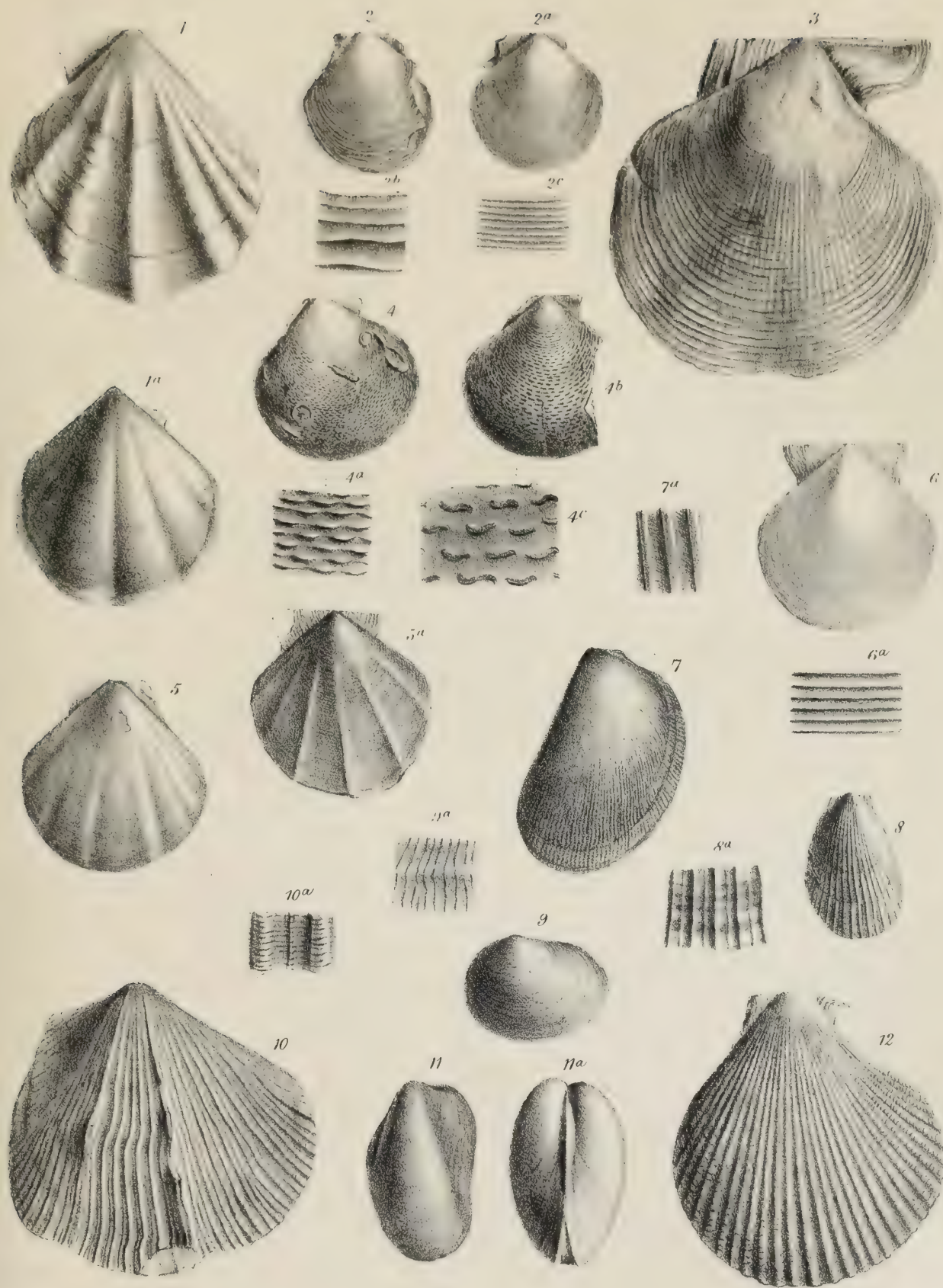




# TAB. XXXIII.

FIG.

1. Pecten inæquicostatus, *Phil.* Left valve. Cornbrash (page 32).
- 1 *a.* „ „ Right valve.
2. Pecten Wollastonensis, *Lyc.* Great Oolite (page 33). Right valve.
- 2 *b.* „ „ Magnified surface of the right valve.
- 2 *a.* „ „ Left valve.
- 2 *c.* „ „ Magnified surface of the left valve.
3. „ Michelensis, *Buv.* Cornbrash (page 34).
4. „ Rushdenensis, *Lyc.* Cornbrash (page 33).
- 4 *a.* „ „ Magnified portion of the right valve.
- 4 *b.* „ „ Left valve.
- 4 *c.* „ „ Magnified portion of the left valve.
5. „ anisopleurus, *Buv.* Right valve. Cornbrash (page 34).
- 5 *a.* „ „ Left valve.
6. „ Griesbachi, *Lyc.* Left valve. Great Oolite (page 37).
- 6 *a.* „ „ Portion of the surface magnified.
7. Lima rigidula, *Phil.*, sp. Cornbrash (page 42).
- 7 *a.* „ „ Portion of the surface magnified.
8. „ Helvetica, *Oppel.* Cornbrash (page 41).
- 8 *a.* „ „ Portion of the surface magnified.
9. Placunopsis semistriatus, *Bean*, sp. Cornbrash (page 30).
- 9 *a.* „ „ Portion magnified.
10. Hinnites gradus, *Bean*, sp. Cornbrash (page 35).
- 10 *a.* „ „ Portion magnified.
- 11, 11 *a.* Modiola gibbosa, *Sow.* Cornbrash (page 42).
12. Pecten articulatus, *Schloth.* Cornbrash (page 34).





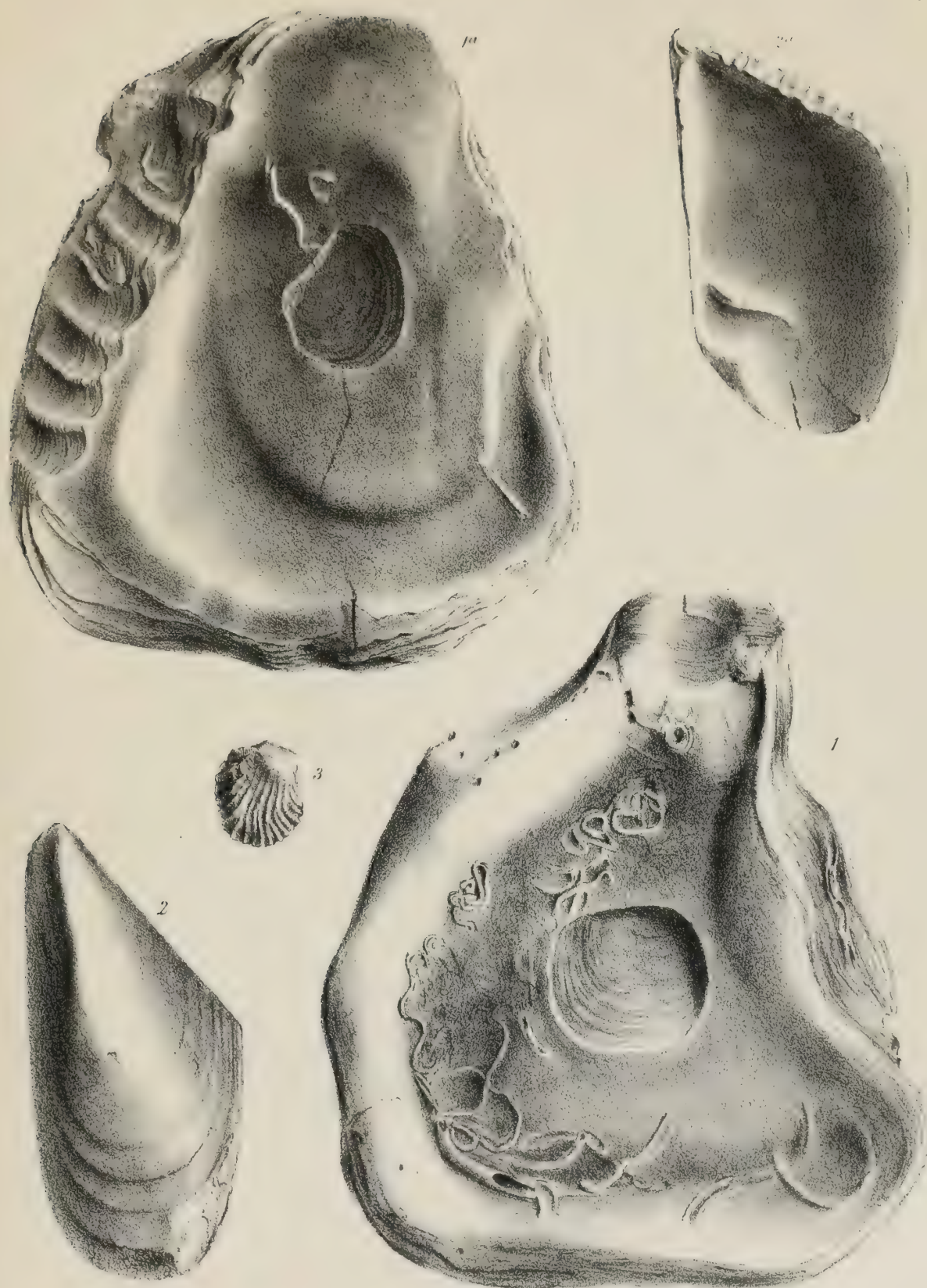




TAB. XXXIV.

FIG.

1.        *Ostrea Wiltonensis*, *Lyc.*    Forest Marble.
- 1 *a.*        „                    „                    A monstrosity of the same species.
- 2, 2 *a.*    *Perna obliqua*, *Walton*, MSS.    Forest Marble.
3.        *Ostrea costata*, *Sow.*    Great Oolite.    Also Part II, Tab. I, fig. 5, page 3.









TAB. XXXV.

FIG.

1. Corbis elliptica, *Whiteaves*, MSS. Forest Marble. Slightly enlarged (page 60).
- 2, 2 a. Cardium subtrigonum, *Mor.* and *Lyc.* Great Oolite. See also Part II, Tab. VII,  
fig. 3, page 64.
3. Sowerbya triangularis, *Phil.*, sp. Cornbrash (page 66).
- 3 a. " " Portion of the surface magnified.
- 3 b. " " Hinge of the right valve magnified.
4. Tancredia mactræoides, *Whiteaves*, MSS. Great Oolite (page 68).
5. Astarte rustica, *Walton*, MSS. Great Oolite and Forest Marble (page 76).  
Also Tab. XL, fig. 8.
6. " robusta, *Lyc.* Cornbrash (page 74).
- 6 a. " " A portion of the surface magnified, exhibiting the inter-  
stitial striations.
7. Tancredia gibbosa, *Lyc.* Great Oolite (page 68).
8. Næara Ibbetsoni, *Mor.* Slightly enlarged. Great Oolite. See also Part II,  
Tab. XII, fig. 9.
- 8 a. " " A portion of the surface magnified.
9. Tancredia similis, *Whiteaves*, MSS. Great Oolite (page 68).
10. Isocardia ? nitida, *Phil.* Cornbrash. See also Tab. XXXVIII, figs. 6, 6 a.
- 10 a. " " A portion of the surface magnified.
- 11, 11 a. Cardium lingulatum, *Lyc.* An oblique specimen. Also Tab. XL, fig. 22,  
page 53.
12. Corbicella subæquilatera, *Lyc.* Cornbrash (page 69).
13. Cyprina Islipensis, *Lyc.* Great Oolite. Our figure is scarcely sufficiently  
lengthened and inequilateral (page 70).
- 14, 14 a. Cardium incertum, *Phil.* Great Oolite (page 53).
15. Anatina (Cercomya) siliqua, *Ag.* Cornbrash (page 83).
16. Astarte politula, *Bean.* Cornbrash (page 73).
- 17, 17 a. Myacites sinistra, *Ag.*, sp. Cornbrash. A breadth of two lines would require to  
be added to the posterior side to render the  
outline perfect (page 82).
- 17 b. " " A portion of the surface magnified.
- 18, 18 a. Pholadomya ovulum, *Ag.* Cornbrash (page 84).
19. Corbis Neptuni, *Lyc.* Great Oolite (page 59).
20. Astarte unguolata, *A. lurida*, *Phil.*, non *Sow.* Cornbrash (page 72).













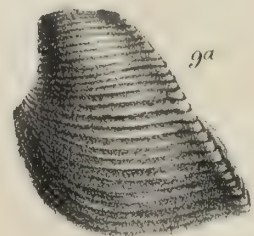
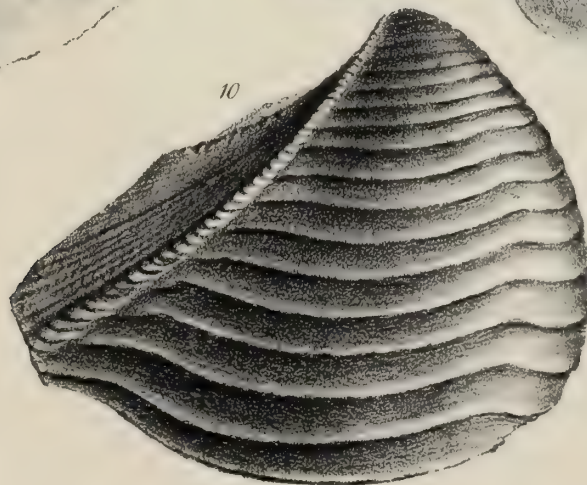
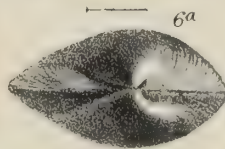
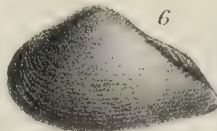
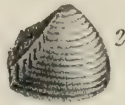
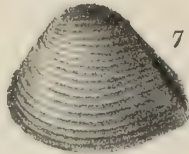
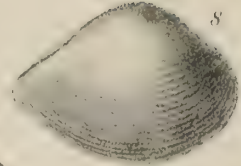
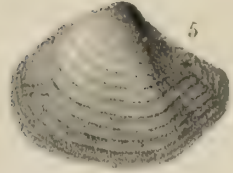
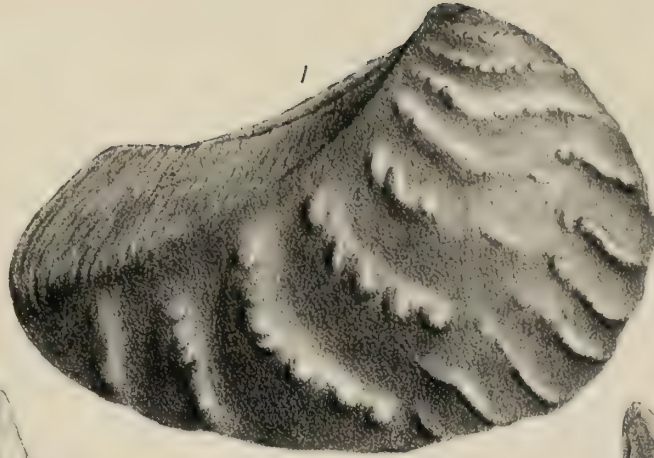
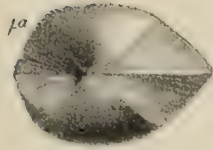
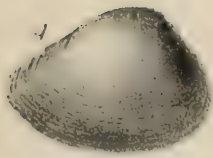


TAB. XXXVII.

FIG.

1. Trigonía Scarburgensis, *Lyc.* Cornbrash (page 48).
2. „ Clythia, *D'Orb.* Great Oolite (page 48). See also Tab. XL, fig. 5.
- 3, 3 a. Perna foliacea, *Lyc.* Great Oolite (page 38).
- 4, 4 a. Corbula involuta, *Munst.* Enlarged. Great Oolite (page 63).
5. „ Hulliana, *Mor.* Enlarged. Forest Marble (page 64).
- 6, 6 a. „ attenuata, *Lyc.* Enlarged. Great Oolite (page 62).
7. „ Islipensis, *Lyc.* Enlarged. Great Oolite (page 63).
8. „ Buckmani, *Buck.*, sp. Great Oolite. Also Part II, Tab. IX, fig. 6,  
page 97.
- 9, 9 a. Opis Leckenbyi, *Wright.* Cornbrash (page 61).
10. Trigonía Cassiope, *D'Orb.* Cornbrash (page 49).







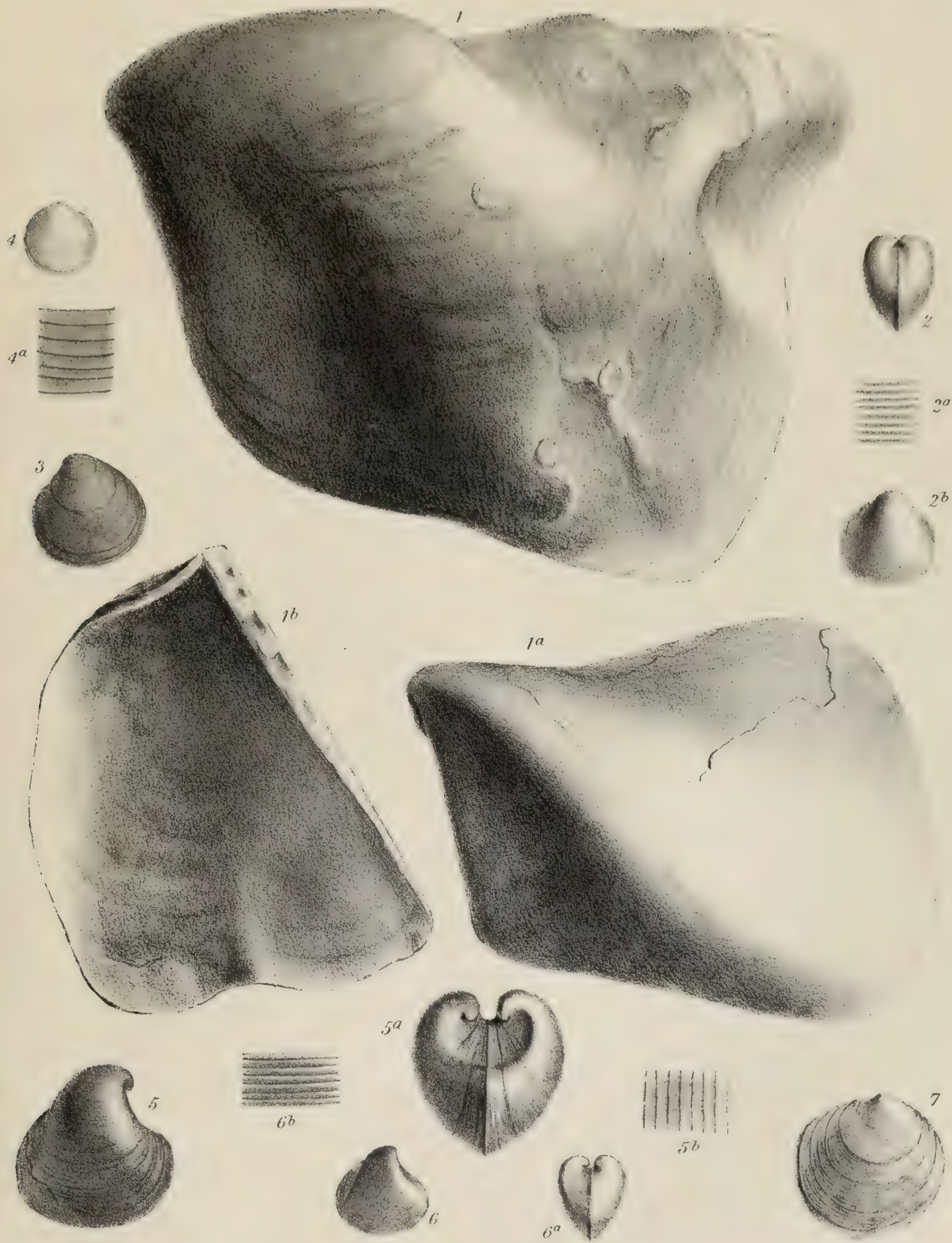




TAB. XXXVIII.

## FIG.

- |         |   |   |
|---------|---|---|
| 1.      | <i>Inoceramus quadratus</i> , <i>Sow.</i> , sp.   | An aged example (page 38).  |
| 1 a.    | „ „   | A smaller specimen, partially denuded of the test, and exhibiting concentric and radiating striations upon the surface of the cast. |
| 1 b.    | „ „   | Interior of the right or flat valve.  |
| 2, 2 b. | <i>Cardium globosum</i> , <i>Bean</i> .           | Cornbrash. The original specimen figured by Mr. Bean (page 114).  |
| 2 a.    | „ „   | Portion of the surface magnified.   |
| 3.      | <i>Lucina</i> ? <i>Beanii</i> , <i>Bean</i> , sp. | Cornbrash (page 59).  |
| 4.      | „ <i>despecta</i> , <i>Phil.</i>                  | Cornbrash (Part II, p. 69).   |
| 4 a.    | „ „   | Portion of the surface magnified.   |
| 5, 5 a. | <i>Isocardia tenera</i> , <i>Sow.</i>             | Cornbrash. Part II, p. 57.  |
| 6, 6 a. | „ <i>nitida</i> , <i>Phil.</i>                    | Cornbrash (page 57). Also Tab. XXXV, fig. 10.   |
| 6 b.    | „ „   | Portion of the surface magnified.   |
| 7.      | <i>Lucina striatula</i> , <i>Buv.</i>             | Cornbrash (page 58).  |









TAB. XXXIX.

FIG.

1.        *Lima pectiniformis*, *Schloth.*    A large specimen, with tubular spines (page 39).
2.        *Nucula Menkei*, *Roem.*    Great Oolite (page 44).    See also Tab. XL, fig. 12.
3.        *Cucullæa corallina*, *Lyc.*    Cornbrash (page 43).
- 4, 4 *a.*        „        *clathrata*, *Leck.*    Cornbrash (page 44).
5.        *Isoarca Scarburgensis*, *Lyc.*    Cornbrash (page 45).
- 5 *a.*        „        „        Portion of the surface magnified.
- 6, 6 *a.*    *Trigonia elongata*, *Sow.*    Cornbrash (page 46).
7.        *Leda Anglica*, *D' Orb.*    Cornbrash (page 45).









# TAB. XL.

FIG.

1. *Trigonia compta*, *Lyc.* Collyweston Slate (page 50).
2. „ *arata*, *Lyc.* Forest Marble (page 52).
3. „ *Bathonica*, *Lyc.* Great Oolite (page 52.)
4. „ *tripartita*, *Forbes.* Cornbrash (page 51.)
5. „ *Clythia*, *D'Orb.* Great Oolite. A specimen of advanced growth.
- 5 *a.* „ „ An adult specimen (pages 48 and 51).
6. „ *tuberculosa*, *Lyc.* Great Oolite. Magnified (page 47).
7. *Avicula clathrata*, *Lyc.* The smaller valve, magnified. Great Oolite.
- 7 *a.* „ „ The larger valve, magnified (page 36).
- 7 *b.* „ „ Portion of the surface magnified.
- 8, 8 *a.* *Astarte rustica*, *Walton*, MSS. Great Oolite and Forest Marble (page 76).
9. *Corbicella subangulata*, *Lyc.* Forest Marble (page 70).
10. *Astarte ignota*, *Lyc.* Forest Marble (page 77).
11. *Pecten personatus*, *Goldf.*, var. Great Oolite. Magnified. Part II, page 11.
- 11 *a.* „ „ Another variety, magnified.
12. *Nucula Menkei*, *Roem.*, var. Also Tab. XXXIX, fig. 2, page 44.
13. *Astarte Aytonensis*, *Bean.* Great Oolite (page 78).
14. *Pecten subspinosus*, *Schloth.* Forest Marble (page 113).
15. *Cyprina bella*, *Walton*, MSS. Forest Marble (page 71).
- 15 *a.* „ „ A shorter specimen.
16. *Pecten rigidus*, *Sow.* Great Oolite (page 31).
17. *Corbis rotunda*, *Lyc.* Forest Marble (page 60).
- 18, 18 *a.* *Cardium Buckmani.* Young specimen. Forest Marble. Part II, page 64.
- 18 *b.* „ „ The striated surface magnified.
- 19, 19 *a.* *Opis Luciensis*, *D'Orb.* Great Oolite (page 62).
- 20, 20 *a.* *Lucina? Burtonensis*, *Lyc.* Forest Marble (page 59).
21. *Gervillia bicostata*, *Lyc.* Great Oolite.
22. *Cardium lingulatum*, *Lyc.* Also Tab. XXXV, fig. 11, page 53.
- 23, 23 *a.* *Astarte Bathonica*, *Lyc.* Great Oolite (page 76).
24. *Avicula subcostata*, *Roem.* Great Oolite (pages 36, 111).
25. *Gervillia tortuosa*, *Sow.*, var. Cornbrash (page 37).
26. *Astarte flexicostata*, *Lyc.* Great Oolite (page 79).
- 27, 27 *a.* *Sowerbya Woodwardi*, *Lyc.* Left valve. Great Oolite (page 67).
- 27 *b.*, 27 *c.* „ „ Right valve.
- 28, 28 *a.* *Corbula Agatha*, *D'Orb.* Forest Marble. Magnified (page 65).
29. *Lithodomus Porteri*, *Lyc.* Forest Marble. Magnified (page 114).
30. *Gryphæa minuta*, *Sow.* Great Oolite. Magnified (page 30).
31. *Astarte Pontonis*, *Lyc.* Great Oolite. Magnified (page 75).
32. *Lima punctatilla*, *Lyc.* Great Oolite. Magnified (page 41).
33. *Astarte orbicularis*, *Sow.* Great Oolite. Magnified (page 73).
- 34, 34 *a.* „ *fimbriata*, *Walton*, MSS. Forest Marble (page 77).
35. *Gervillia Islipensis*, *Lyc.* Great Oolite (page 37).
36. *Cardium Witchelli*, *Lyc.* Great Oolite. Magnified (page 55).











# TAB. XLI.

FIG.

1. *Amberleya capitanea*, *Goldf.*, sp. Forest Marble (page 95).
- 2, 2 *a.* *Natica Hulliana*, *Lyc.* Great Oolite (page 13).
3. *Amberleya nodosa*. See also Part I, Tab. V, fig. 19.
4. *Acteonina olivæformis*. Great Oolite and Forest Marble. See also Part I, Tab. VIII, fig. 14, and fig. 12\*.
- 4 *a.* „ „ A specimen of more advanced growth, with the spire more produced.
5. „ *Kirklingtonensis*, *Lyc.* Great Oolite (page 26).
6. „ *brevis*, *Lyc.* See also *Cylindritis? brevis*, Part I, Tab. VIII, fig. 13, page 26.
- 7, 7 *a.* *Nerita Buvignieri*. Examples of two stages of growth. See also *Stomatia Buvignieri*, Part I, Tab. IX, fig. 32. The specimens now figured are from the Forest Marble of Laycock.
- 8, 8 *a.* *Ammonites discus*, *Sow.* Forest Marble. Slightly reduced (page 4).
9. *Rissoina subulata*, *Lyc.* Great Oolite. Enlarged (page 98).
10. *Amberleya monilifera*, *Lyc.* Forest Marble. Enlarged (page 95).
11. *Cerithium costigerum*, *Piette*. Variety with flattened volutions and oblique costæ (page 92).
- 11 *a.* „ „ A portion of the surface enlarged.
- 11 *b.* „ „ Specimen with shorter, more inflated volutions, and perpendicular costæ.
- 11 *c.* „ „ A portion of the surface enlarged.
12. *Kilvertia pulchra*, *Lyc.* Great Oolite and Forest Marble. For the form of the aperture see Tab. XLIV, fig. 4, pages 10 and 94.
12. „ „ A portion of the surface enlarged.
13. *Alaria myurus*, *Desl.* See also *Alaria lævigata*, Part I, Tab. III, fig. 3.
14. *Amberleya tricincta*, *Lyc.* Forest Marble (page 96).
15. *Turbo subtexatus*, *Lyc.* Forest Marble.
16. *Cerithium? Waltoni*, *Lyc.* Forest Marble (page 92).
17. „ *hemicinctum*, *Lyc.* Forest Marble. Enlarged (page 91).
- 18, 18 *a.* *Acteonina Luidii*, *Mor.* An adult specimen, with the spire moderately elevated. Forest Marble. See also Tab. XXXI, fig. 16, page 27.
- 18 *b.* „ „ A specimen with the spire elevated.
- 18 *c.* „ „ Specimen with the spire elevated and the last whorl unusually lengthened.





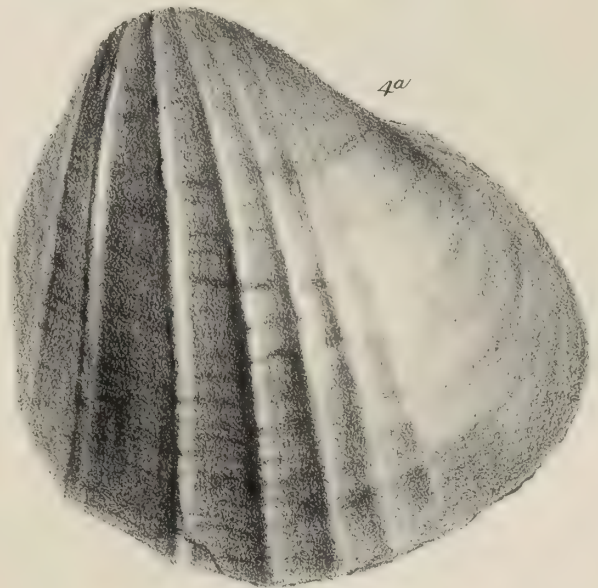
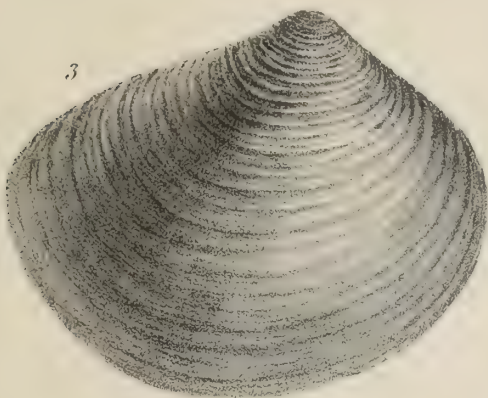
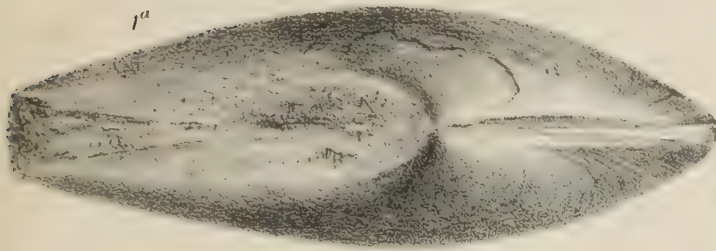
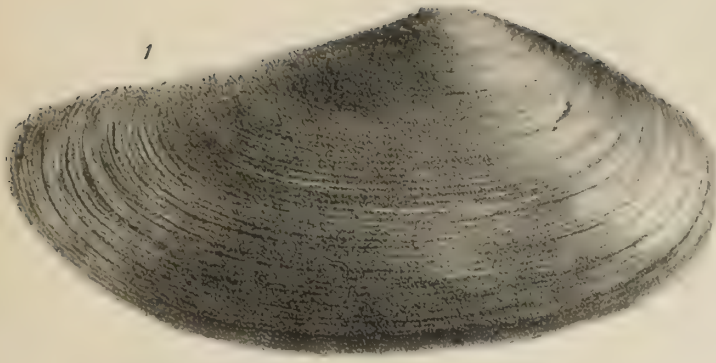




TAB. XLII.

FIG.

- 1, 1 *a*. *Myacites calceiformis*, *Phil.*, sp. Cornbrash. Specimen with the test preserved  
(page 80).
- 2, 2 *a*. *Pholadomya Phillipsi*, *Mor.* Cornbrash (page 85).
3. *Astarte Leckenbyi*, *Wright*. Cornbrash (page 74).
- 4, 4 *a*. *Pholadomya deltoidea*, *Sow.* Forest Marble (page 86).







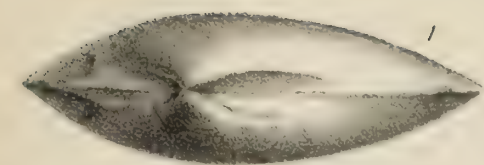


TAB. XLIII.

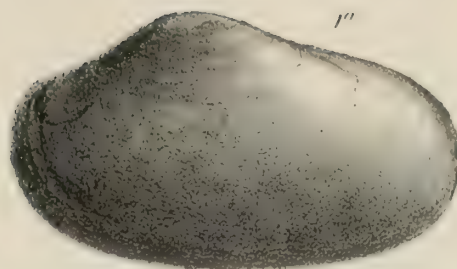
FIG.

- 1, 1 *a*. *Myacites modica*, *Bean*, sp. Cornbrash (page 83).
- 2, 2 *a*. *Homomya gibbosa*, *Sow.*, sp. (Page 88.)
- 3, 3 *a*. *Pholadomya lyrata*, *Sow.* Cornbrash (page 87).
4. *Thracia amygdaloidea*, *Lyc.* Great Oolite (page 80).
- 5, 5 *a*. *Homomya crassiuscula*. An adult specimen, with the test preserved. Part II,  
page 112; Supplement, page 89.

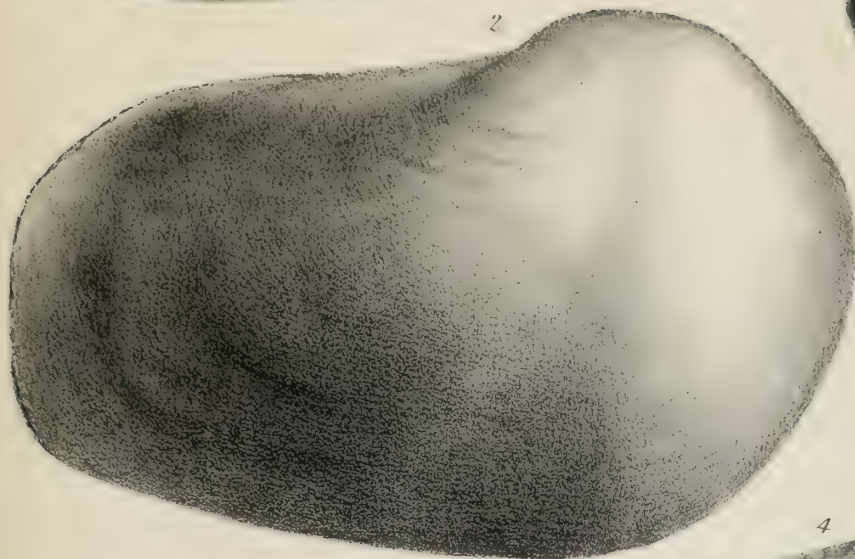




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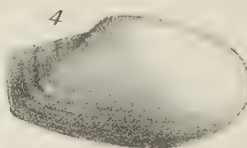
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2



3



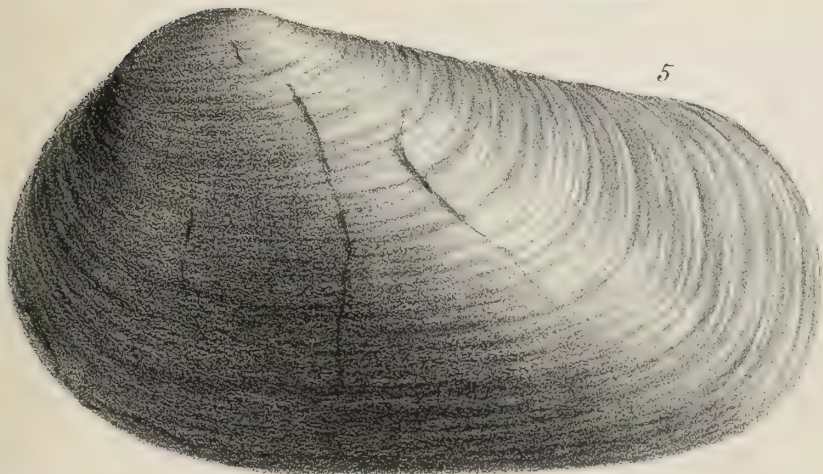
4



3a



2a



5



5a







TAB. XLIV.<sup>1</sup>

FIG.

1. Kilvertia spicula, *Lyc.* Great Oolite. Enlarged (page 9).
2. „ strangulata, *D'Arch.* Great Oolite. For another variety see Part I, Tab. IX, fig. 18.
3. Cerithium bulimoides, *Desl.* Great Oolite. Enlarged (page 7).
4. Kilvertia pulchra. Great Oolite. Enlarged. See also Tab. XLI, fig. 12, page 10.
5. „ formosa, *Lyc.* Great Oolite. Enlarged (page 95).
6. Cerithium undulatum, *Desl.* Great Oolite. Enlarged (page 8).
7. „ Witchelli, *Lyc.* Great Oolite. Enlarged (page 10).
8. Chemnitzia constricta, *Lyc.* Great Oolite. Enlarged. Printed Kilvertia by mistake at page 15.
9. Cerithium compositum, *Lyc.* Great Oolite. Enlarged (page 9).
10. Rissoina Milleri, *Lyc.* Great Oolite. Enlarged (page 18).
11. Rissoa? exigua, *Lyc.* Great Oolite. Enlarged (page 9).
12. Rissoina *Witchelli.* Great Oolite. Enlarged (page 18).
13. Rissoina? tumidula, *Lyc.* Great Oolite. Enlarged (page 98).
14. Cyldindrites exigua, *Lyc.* Great Oolite. Enlarged (page 24).
15. Acteonina fasciata, *Lyc.* Forest Marble. Enlarged (page 107).
16. Acteon Bathonicum, *Lyc.* Great Oolite. Enlarged (page 25).
17. Brachytrema buccinoidea, *Lyc.* Great Oolite. Enlarged (page 5).
18. Acteonina scalaris, *Lyc.* A small specimen from the Great Oolite (page 28).
19. Cerithium? Bathonicum, *Lyc.* Great Oolite. Enlarged (page 6).
20. „ multiforme, *Piette.* Great Oolite. Enlarged (page 7).
21. „ ? neglectum, *Lyc.* Great Oolite. Enlarged (page 92).
22. Ceritella Morrisea, Orthostoma, *Buv.* See also Part I, Tab. IX, fig. 14.
23. Cerithium exscalptum, *Lyc.* Great Oolite. Enlarged (page 93).
24. „ poculum, *Lyc.* Great Oolite. Enlarged (page 93).
25. Ceritella Lycettea, Orthostoma, *Buv.* See also Part I, Tab. IX, fig. 7.
- 26, 26 a. Cyldindrites turriculatus, *Lyc.* Great Oolite. Enlarged (fig. 25).
27. Brachytrema varicosa, *Lyc.* Great Oolite. Enlarged (page 5).
28. Acteon phasianoides, *Lyc.* Great Oolite. Enlarged (page 26).
29. Monodonta exigua, *Lyc.* Great Oolite. Enlarged (page 22).

<sup>1</sup> All the fossils upon this Tab., excepting No. 15, were obtained by crushing shelly portions of the Great Oolite.









# TAB. XLV.

FIG.

1. *Monodonta Lyellii*, *D'Arch.*, sp. Young shell. For the adult condition see Part I, Tab. XI, fig. 4.
2. *Natica arata*, *Lyc.* Great Oolite. Enlarged (page 97).
3. *Nerita clavatula*, *Lyc.* Great Oolite. Enlarged (page 98).
4. *Ceritella fusiformis*, *Lyc.* Great Oolite. Enlarged (page 12).
5. „ *minutissima*, *Lyc.* Great Oolite. Enlarged (page 11).
6. *Monodonta composita*, *Lyc.* Great Oolite. Enlarged (page 23).
7. *Pleurotomaria recondita*, *Lyc.* Great Oolite. Enlarged (page 106).
8. „ *Burtonensis*, *Lyc.* Forest Marble (page 105).
- 8 a. „ „ The base.
- 8 b. „ „ Portion of the surface magnified.
9. *Monodonta sparsistriata*, *Lyc.* Great Oolite. Magnified (page 22).
10. *Pleurotomaria Bathonica*, *Lyc.* Great Oolite. Magnified (page 105).
- 11, 11 a. *Onustus Burtonensis*, *Lyc.* Forest Marble. Slightly enlarged (page 103).
12. *Trochus strigosus*, *Lyc.* Cornbrash (page 29).
13. *Turbo depauperatus*, *Lyc.* Forest Marble. See also *Pleurotomaria pagodus*, Part I, Tab. X, fig. 9.
14. *Trochus Guisei*, *Lyc.* Great Oolite. Magnified (page 21).
15. *Turbo Burtonensis*, *Lyc.* Forest Marble (page 100).
16. *Trochus Burtonensis*, *Lyc.* Forest Marble (page 99).
17. *Monodonta tegulata*, *Lyc.* Forest Marble. Specimen with fine striations (page 102).
18. „ „ Forest Marble. Enlarged.
19. „ *arata*, *Lyc.* Forest Marble. Enlarged (page 102).
20. „ „ Variety with the encircling lines more distantly arranged.
21. *Natica insignis*, *Lyc.* Great Oolite. Enlarged (page 97).
22. „ (*Euspira*) *alta*, *Lyc.* Forest Marble (page 97).
23. *Solarium turbiniformis*, *Lyc.* Forest Marble (page 104).
- 23 a. „ „ A portion of the surface enlarged.
- 23 b. „ „ The lower surface.
- 24, 24 a. *Monodonta comma*, *Lyc.* Forest Marble (page 101).
- 24 b. „ „ A portion of the surface enlarged.
25. *Acteonina Wiltonensis*, *Lyc.* Forest Marble (page 107).
- 26, 26 a. *Solarium Waltoni*, *Lyc.* Forest Marble. Upper surface and profile (page 104).
- 26 b, c. „ „ Forest Marble. Lower surface.
- 27, 27 a. *Solarium Bathonicum*, *Lyc.* Great Oolite. The upper surface and profile (page 23).
- 27 b, 27 c. „ „ The lower surface of a smaller specimen.
- 27 d. „ „ A portion of the upper surface magnified.
- 28, 28 a, 28 b. *Phasianella variata*, *Lyc.* Page 104.
29. *Acteonina Suessea*, *Lyc.* Forest Marble (page 107).
- 30, 30 a. *Natica texata*, *Lyc.* Forest Marble (page 96).
- 31, 31 a. *Monodonta Waltoni*, *Lyc.* Forest Marble. Enlarged (page 101).
- 31 b. „ „ A portion of the striated surface magnified.

















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